

Future of Minimally Invasive Cardiac Surgery

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The ultimate goal of minimally invasive cardiac surgery (MICS) is the perfection of totally endoscopic cardiovascular surgery, without the need for thoracotomy; instead opening a number of access apertures (≤ 1 cm), and treating cardiovascular conditions using only the endoscope and narrow instruments.

The first step on the road to minimally invasive surgery was endoscopic cholecystectomy, commenced in earnest in America and Europe in 1988. This minimally invasive method of removing the gall bladder laparoscopically, without the need for laparotomy, has a high level of patient satisfaction attributable to decreased postoperative pain, better cosmetic appearance due to the lack of a laparotomy scar, and earlier recovery, discharge and return to activities. The introduction of minimally invasive surgery techniques to cardiovascular surgery have been extremely difficult, however, due to the need to manipulate the heart and aorta, usually under cardiopulmonary bypass (CPB), and technical difficulties with endoscopic surgery.

Following training and animal experiments, in July 1992 we successfully performed the first endoscopic interruption of patent ductus arteriosus.¹⁾ This success was the first application of minimally invasive surgery in the cardiovascular field, and a prelude to MICS in Japan. The first use of MICS in coronary arterial bypass grafts (CABG) was in 1994, from which time off-pump minimally invasive minithoracotomy CABG not requiring CPB has again attracted attention. Since 1996, the application of minimally invasive surgery has widened to include the correction of intracardiac conditions requiring CPB, such as valvular disease and congenital heart disease. In November 1996, we successfully performed, for the first time in Japan, mitral and aortic valve replacements and closure of an atrial septal defect, using a

minithoracotomy (MICS) where a midline sternotomy would previously have been used.²⁾ In June 1998, we achieved excellent results with the first operation performed in Japan using the Port-Access technique, devised by Heartport, Inc. (open heart surgery via small access ports in the chest wall) in the U.S. in 1995, consisting of correction of a congenital heart defect, CABG and mitral valve repair.³⁾ In June 1998, the first CABG operation was performed in Europe using the computer-controlled telemanipulation system (the "da Vinci" robot by Intuitive Surgical, Inc., U.S.A.), the only access being 3 small access ports (≤ 1 cm) in the left side of the patient's chest. This computer-controlled robot telemanipulation system consists of a robot stationed by the patient, with 3 arms inserted into the patient's chest, and a console situated at a distance from the patient, where the cardiac surgeon manipulates the controls watching a 3-dimensional high-resolution videoscopic image. This robot enables the faithful and accurate transmission of the complicated and delicate manipulations made by the cardiac surgeon (including anastomosis, suture, ligation and dissection of blood vessels 1 mm in diameter) to the manipulators in the patient's chest, through 3 small access ports without the need for thoracotomy. In March 1999, when I actually used the da Vinci robot to anastomose the internal mammary artery to a coronary artery (left anterior descending branch) in a pig, my impression was that it was easier than performing the anastomosis in the usual manner. In Germany, in January and March 2000, totally endoscopic beating heart CABG (TECABG) was performed without CPB. There are a number of problems that must be overcome before TECABG using the da Vinci telemanipulation system becomes widespread.⁴⁾ The first would be the development of a better stabilizer suited to the closed chest space, and miniaturization of the da Vinci apparatus. To perfect the TECABG technique, another da Vinci robot for the assistant may be necessary. The first MICS using the da Vinci robot will be performed in Japan in the near future, by the team at the Keio University, led by Dr. Yozu. A number of medical equipment manufacturers have

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developed automated mechanical devices for performing distal and proximal anastomoses in coronary bypass surgery. Marketing of a device to effect an anastomosis between the ascending aorta and a venous graft is planned in the near future.⁵⁾ If this device makes a rapid and accurate anastomosis possible, complications of the procedure such as cerebral infarction and stroke due to partial clamping and manipulation of the ascending aorta will be lessened, and good coronary arterial bloodflow from the ascending aorta should be achieved. In other words, we will be one step closer to the ideal for TECABG of being less invasive, with fewer complications. With further improvements and refinements in a number of areas, the day that we achieve the ultimate goal of MICS may not be all that far away.

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