Robotic Cardiac Surgery
Robotic Cardiac Surgery is a comprehensive academic compilation of experience with robotic surgery in all phases of cardiac surgery as well as an extensively illustrated manual of how to do robotic cardiac surgery for several forms of acquired and congenital heart disease. The author, Dr. Changqing Gao, is an experienced robotic surgeon who has published much of his work in the peer-reviewed literature around the world and has held several excellent meetings and clinics to teach surgeons around the world how to do robotic cardiac surgery safely and effectively.

One of the main principles illustrated in the book is in order to achieve excellent results utilizing robotic cardiac surgery you have to have excellent results in the conventional approach throughout all aspects of acquired and congenital heart surgery. It has been documented that experienced surgeons will become the leaders in the field of robotic cardiac surgery. Dr. Gao and his colleagues are very experienced surgeons, and their robotic surgery techniques and results are of the highest quality and are well documented in the pages of this book.

Under acquired heart disease, primarily a robotic approach to mitral and tricuspid repair and replacement are discussed. The results of robotic surgical treatment for atrial septal defects and other smaller defects are outlined in the congenital section. The use of robotics for the take-down of the left internal mammary artery in performing CABG either by itself or with hybrid revascularization in conjunction with the placement of drug eluting or bare metal stents in other arteries is described in great detail. Hybrid revascularization stems from early work with minimally invasive valve surgery and single vessel lesions managed by a percutaneous coronary stent rather than a CABG and followed by a minimally invasive valve operation. This is now carried to the next step with robotic surgery performing a LIMA to the left anterior descending artery in combination with percutaneous coronary stents for some less important arterial obstructions. Again, the results are quite good and the techniques are extensively illustrated in this book. The last section is robotic left ventricular epicardial lead implantation, an area that may be helpful in the treatment of heart block or other arrhythmogenic entities that require cardiac rhythm therapy.

All chapters are beautifully illustrated so as to enhance the reader’s understanding of robotic operations. Chapters in the book are primarily written by expert surgeons, anesthesiologists and cardiologists in China where this technology has had very good results. This book will be a landmark in presenting large clinical series results of conventional operations treated by robotic technology.

Lawrence H. Cohn, MD
Harvard Medical School
Since robotic technology was introduced into the cardiac surgical field in 1998, the dream of cardiac surgeons to perform cardiac procedures in the closed chest has come true. With an outlook into the future, the PLA General Hospital took the lead to install the first da Vinci S Surgical System in China in 2006. The surgical team of the PLA General Hospital has started the cutting-edge techniques of minimally invasive robotic surgery in China.

Our team had gone through tremendous trial investigations and hard work before they finally succeeded in using da Vinci S Surgical System in China. After working persistently with da Vinci S Surgical System for 7 years, we now can perform the whole range of closed-chest heart procedures that da Vinci S Surgical System was designed for. Exceeding and renovating the desired techniques designed for the System, the surgeons of the team created new surgical techniques and standards, and completed the most types of robotic cardiac surgery on the globe. So far, the team has performed 700 cases all of which were successful.

We were eager to share our experience with other surgical teams around the world. We established the National and International Training Center for Robotic Cardiac Surgery in Beijing, China. The center has provided training programs for groups of cardiac surgical professionals from other countries and regions like Japan, Singapore, Brazil, Korea, Hong Kong and Taiwan. Advances in robotic heart surgery in China have exerted far-reaching impacts in Asia and even around the world.

China has a tremendous patient base and a large pool of talented and innovative surgeons with extensive surgical experience. For sure, the full potential of da Vinci surgery will be realized through the increased exchanges between Chinese surgeons and their counterparts around the world.

We have written this book to record the landmark, to share our experience and to acknowledge the care and help given by our mentors and colleagues from all parts of the world.

Beijing, People’s Republic of China

Changqing Gao, MD
Dr. Changqing Gao is currently the Vice President of the PLA General Hospital, the Chairman and Professor of the Department of Cardiovascular Surgery, Director of the Institute of Cardiac Surgery, the National Training Center for Robotic Cardiac Surgery, International Training Center for da Vinci Surgery, and International Cooperation and Research Center for Robotic Cardiac Surgery.

Dr. Gao has performed over 4,000 cases of cardiovascular surgery and has become a nation-renowned expert in the surgical field. His professional interests include acquired heart disease, mitral and aortic valve repair/replacement, and aneurysms of the thoracic aorta. He has a special interest in complex coronary artery bypass, off-pump coronary artery bypass, left ventricular aneurysms, and minimally invasive cardiac surgery.

Dr. Gao is a pioneering surgeon in robotic cardiac surgery in Asia. He has completed 700 cases of robotic cardiac surgery with da Vinci Surgical Systems since 2007. He has been a recipient of many research grants and fellowship, and numerous awards for his excellence and achievements in science and technology. He is currently the principal investigator in a number of major clinical research projects in China.

Dr. Gao is the Executive Councilor of the Asian Society for Cardiovascular and Thoracic Surgery (ASCVTS), Board of Director of ISMICS and the Minimally Invasive Robotic Association (MIRA), Charter member of the Society of Robotic Surgery (SRS), Member of AATS, STS and EACTS, Councilor of the Chinese Medical Association, Vice President and Secretary General of the Chinese Society of Thoracic and Cardiovascular Surgery, Vice President of the Chinese Association of Cardiovascular Surgeons, President of the Beijing Society of Cardiac Surgery, and Executive Councilor of the Beijing Medical Association.
Dr. Gao is the Co-editor of the *Journal of Robotic Surgery* of USA, Board member of the *Heart Surgery Forum*, Board member of *Innovations*, Associate Editor-in-chief of the *Journal of Thoracic and Cardiovascular Surgery*, Editor-in-chief of the *Chinese Journal of Extracorporeal Circulation*, and Associate Editor-in-chief of the *Chinese Journal of Thoracic and Cardiovascular Surgery*. He also holds membership of the editorial boards of many influential medical journals.
The authors gratefully acknowledge the assistance of the following individuals and organizations whose contributions made publication of this book possible:

PLA General Hospital, PLA Medical School, Beijing, China

Karen Zhao, MA
Junlan Yan, RN
Jiali Wang, BS
Jiachun Li, BS
Guopeng Liu, MS
Yue Zhao, RN
Lixia Li, RN
Bojun Li, MD
Shengli Jiang, MD
Rong Rong, MD
## Contents

1 Overview of Robotic Cardiac Surgery ................................................. 1  
   Changqing Gao

2 Anesthesia for Robotic Cardiac Surgery ........................................... 15  
   Gang Wang and Changqing Gao

3 Intraoperative Transesophageal Echocardiography in Robotic Cardiac Surgery ................................................. 33  
   Yao Wang and Changqing Gao

4 Peripheral Cardiopulmonary Bypass Establishment for Robotic Cardiac Surgery ................................................. 49  
   Cangsong Xiao and Changqing Gao

5 Robotic Surgery in Congenital Heart Diseases ..................................... 61  
   Changqing Gao and Ming Yang

6 Totally Robotic Myxoma Excision .................................................... 83  
   Changqing Gao and Ming Yang

7 Robotic Mitral Valve Surgery .......................................................... 93  
   Changqing Gao and Ming Yang

8 Robotic Coronary Bypass Graft on Beating Heart .................................. 111  
   Changqing Gao and Ming Yang

9 Hybrid Coronary Revascularization ................................................... 135  
   Mukta C. Srivastava, Bradley Taylor, David Zimrin, and Mark R. Vesely

10 Robotic Left Ventricular Epicardial Lead Implantation ............................ 141  
    Changqing Gao, Chunlei Ren, and Ming Yang

Index ........................................................................................................ 147
Contributors

**Changqing Gao, MD**  Department of Cardiovascular Surgery, PLA General Hospital, Beijing, People’s Republic of China

**Chunlei Ren**  Department of Cardiovascular Surgery, PLA General Hospital, Beijing, People’s Republic of China

**Mukta C. Srivastava, MD**  Division of Cardiology, University of Maryland Medical Center, Baltimore, MD, USA

**Bradley Taylor, MD**  Division of Cardiology, University of Maryland Medical Center, Baltimore, MD, USA

**Mark R. Vesely, MD**  Division of Cardiology, University of Maryland Medical Center, Baltimore, MD, USA

**Gang Wang, MD**  Department of Cardiovascular Surgery, PLA General Hospital, Beijing, People’s Republic of China

**Yao Wang, MD**  Department of Cardiovascular Surgery, PLA General Hospital, Beijing, People’s Republic of China

**Cangsong Xiao, MD**  Department of Cardiovascular Surgery, PLA General Hospital, Beijing, People’s Republic of China

**Ming Yang, MD**  Department of Cardiovascular Surgery, PLA General Hospital, Beijing, People’s Republic of China

**David Zimrin, MD**  Department of Medicine, University of Maryland School of Medicine, Baltimore, MD, USA