Editorial

Fifty Years of Open-Heart Surgery

Lawrence H. Cohn, MD

On May 6th, 2003, we celebrate the 50th anniversary of the first successful open-heart operation performed with the use of the heart-lung machine, one of the most important forms of therapy in the history of cardiac disease. On that spring day in Philadelphia, John H. Gibbon, Jr, MD, of the Jefferson University Medical Center, using total cardiopulmonary bypass for 26 minutes, closed a large secundum atrial septal defect in an 18-year-old woman. Beginning with this case, generations of cardiac surgeons have been able to operate on millions of human hearts with alacrity, efficiency, and consistency to correct complicated congenital heart defects, cardiac valve disorders in the young and old, atherosclerotic coronary artery obstructions, and large aneurysms of the thoracic aorta.

Until 1953, cardiac surgery was in its infancy and was more of a curiosity, except for treatment of rheumatic mitral stenosis, beginning in 1923 with Cutler’s successful case of a closed mitral commissurotomy with a tenotomy knife at the Peter Bent Brigham Hospital in Boston. The only successful heart operations done before 1953 were closed techniques for mitral stenosis, a few clinical experiments in 1952 with “open” heart by deep hypothermic arrest by John Lewis at the University of Minnesota, and the “blue-baby” operations of the 1940s and 1950s.

It is not a fluke that John Gibbon was the first to do this procedure. He had studied and worked tirelessly on this project for 23 years before the first successful application. Dr Gibbon, who would have also celebrated his one-hundredth birthday in 2003, was a medical student at Jefferson and finished his residency in surgery at the Pennsylvania Hospital in the late 1920s. In 1930, he obtained a research fellowship with Dr Edward Churchill, the Chief of Surgery at the Massachusetts General Hospital in Boston. On October 3rd, 1930, Dr Gibbon witnessed the collapse of a patient with a massive pulmonary embolism after a general surgical operation. After a period of deteriorating hemodynamics, watched closely by Dr Gibbon at the patient’s bedside all night, the patient underwent a closed pulmonary embolectomy (Trendelenburg operation) performed by Dr Churchill, but to no avail; the patient died. This dramatic clinical experience had a profound and lasting effect on Dr Gibbon and determined his lifetime academic research interest.

Massachusetts General Hospital and later at Jefferson in attempts to develop a machine that could interrupt the circulation by taking over the functions of the heart and lungs, allowing surgeons to remove a clot from the pulmonary circulation and then restore normal hemodynamics.

There obviously had been no machine like this, but a number of investigators in the early years of the 20th century had been working on isolated animal heart support with oxygenated perfusion, perhaps the most famous being that of Charles Lindbergh working with Alexis Carrel in the 1930s. While relatively little had been done to support the circulation in the way that Gibbon foresaw, even the detail of precisely and consistently anticoagulating the blood was a difficult project in the 1930s, though McLean had discovered heparin in 1916. Gibbon persisted for 5 years at the Massachusetts General Hospital fabricating pump after pump to support his thesis and then continued his work in Philadelphia at the University of Pennsylvania in the late 1930s. After World War II, during which he was a distinguished military medical officer, Dr Gibbon returned to Penn for a short time and then became Professor of Surgery at his alma mater, Jefferson. He did his clinical work in the morning and his research work in the surgical laboratories in the afternoon to develop his heart-lung machine (without, I might say, the advantage of National Institutes of Health–supported grants).

In the late 1940s, continuing his work on several different versions of the ever-improving heart-lung machine, he contacted the IBM Corporation to collaborate on manufacturing the possible first human version. This occurred because one of his medical students had been very friendly with Thomas Watson, who was then the Chairman of the Board of IBM. IBM worked with him in developing Model I of the heart-lung machine. Though relatively successful in extensive experimentation in animals, it was ineffective in supporting the total cardiopulmonary bypass system in volumes large enough to support a human being. Many notable peripheral events related to cardiac surgical techniques and technologies occurred during those 23 years of research. He had to decipher every aspect of artificial circulation we now take for granted: how to drain the blood from the body, how to pump it back, how to clear air from the inside of the heart, how to anticoagulate successfully without clotting the machinery, etc.

After the first IBM model failed to work as well as he had hoped, Dr Gibbon developed a second model in his own laboratory, which was the successful machine that eventually allowed human bypass operations. The final design of Model II (Figure) developed in the early 1950s consisted of a screen oxygenator, which allowed blood on both sides of the screen mesh to interface with oxygen, and three roller pumps modified from Dr Michael DeBakey’s original transfusion pump design to pump the blood back into the body. The
tered, which was closed with a running cotton suture. The atrium, a large secundum atrial septal defect was encountered, rarely, if ever, used in modern cardiac surgery. After opening the entire upper thoracic to expose the heart—this was done through a large, bilateral submammary incision, which lifted up the so-called clamshell incision, which exposed the heart and superior vena cava were cannulated with plastic tubes. All this was done through a large, bilateral submammary incision—the so-called clamshell incision, which lifted up the entire upper thoracic to expose the heart—an incision that is rarely, if ever, used in modern cardiac surgery. After opening the atrium, a large secundum atrial septal defect was encountered, which was closed with a running cotton suture. The patient was removed from the heart-lung machine without incident after approximately 26 minutes. She made an uneventful recovery and was discharged 13 days postoperatively. She was recatheterized 6 months postoperatively, and her defect was completely closed. The case was absolutely astounding to those who witnessed it, as it was to the entire world soon after this first successful case was announced in the press.

Dr Gibbon subsequently operated on 2 additional patients in July 1953, both of whom were young girls about 5 years of age with atrial septal defects. These two patients died at surgery with difficulties again of imprecise diagnosis of atrial septal defect and complications related to bleeding during long time periods on the heart-lung machine. After these two cases, Dr Gibbon, quite upset at these failures, declared a moratorium on open-heart surgery with his heart-lung machine. Curiously, Dr Gibbon’s momentous successful case was not published until one year later in a state medical journal, Minnesota Medicine.

Dr Gibbon never again did open-heart surgery, leaving his trainees and countless others in the field to carry out the prodigious cardiac feats that we all know and take for granted today. He maintained only a research interest in the development of subsequent models of the heart-lung machine, but it was immediately apparent that others in the field, who were primarily interested in cardiac surgery, such as Clarence Dennis of Downstate University in Brooklyn, John Kirklin of the Mayo Clinic, and C. Walton Lillehei at the University of Minnesota, would pick up the gauntlet, refine Dr Gibbon’s original heart-lung machine, and use it extensively. With the improvement of diagnosis and preoperative preparation, uniform anticoagulation, and improved postoperative care, heart surgery blossomed in the late 1950s and early 1960s. Dr Gibbon’s Model II heart-lung machine was the framework on which other applications were modeled. The first truly commercial heart-lung machine was the Mayo-Gibbon device, which was the most widely used heart-lung machine of the 1950s and early 1960s and was developed by Kirklin and coworkers at the Mayo Clinic after the design of Dr Gibbon.

After the development of the heart-lung machine, Dr Gibbon returned to the active practice of general thoracic surgery, leaving cardiac surgery to others, recalling that his primary interest had always been thoracic surgery and that his sentinel case of pulmonary embolism was a complication of a general surgical operation. He became Professor and Chairman of Surgery at Jefferson and was President of the American Surgical Association in 1954 and the American Association of Thoracic Surgery in 1961. He gave his last talk on the development of the heart-lung machine at Baylor in late 1972 and shortly thereafter passed away in early 1973 at the age of 69 from a fatal heart attack.

The world owes John H. Gibbon, Jr, MD, an enormous debt of gratitude for pioneering the technology of cardiopulmonary bypass and persisting for 23 years in its development—until he got it just right, on the morning of May 6th, 1953.
References


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