The Heart Surgery Forum #1999-74549
2 (4):341–344, 1999

Online address: www.hsforum.com/vol2/issue4/1999-74549.html

Two New Drainage Tubes for Minimally Invasive Cardiac Surgery

(#1999-74549 … May 21, 1999)

Masahiro Endo, MD, Hiroshi Nishida, MD, Yasuko Tomizawa, MD, Shinichiro Kihara, MD, Toru Ishida, MD, Hitoshi Koyanagi, MD

The Department of Cardiovascular Surgery, The Heart Institute of Japan, Women's Medical University, Tokyo, Japan

Dr. Endo

ABSTRACT

Background: We have developed specialized drainage tubes for minimally invasive cardiac surgery (MICS) as a means to overcome the limited exposure typical of new approaches. These specialized tubes lessen skin injury, improve the cosmetic results, and simplify the implantation of pacing and drainage equipment.

Methods: The first device is a drainage tube with temporary pacing function. It has three fixed electrodes and one free pacing wire incorporated into an elliptical, angled 28 Fr silicone drainage tube. This tube is placed in the space between the heart and the diaphragm. The two fixed electrodes provide epicardial contact for ventricular pacing. The third fixed electrode and one free pacing wire are for the purpose of atrial pacing (Japanese patent #2,701,135). The second device is a Y-shaped drainage tube. Frequently, the pleural space is opened during harvesting of an internal mammary graft and then insertion of a chest tube in the thoracic cavity becomes necessary. We developed a new Y-shaped tube where one segment is placed in the retrosternal space and one segment is placed in the pleural cavity. (Japanese Association of Intellectual Copyright #130,591)

Results: The drainage-pacing device was used in 48 coronary artery bypass grafting (CABG) patients. Drainage function and pacing function were excellent in all patients. The bifurcated drainage device was used in 34 patients achieving effective drainage of both cavities without complication during or after removal.

Conclusions: Due to the limited surgical exposure provided by the newer minimally invasive procedures in cardiac surgery, specialized equipment that can be inserted through small incisions needs to be developed. We report the development of a new drainage-pacing device as well as a bifurcated drain for simultaneous drainage of the mediastinal and pleural cavities. These devices have facilitated minimally invasive cases and were free of complications.

Presented at the Second Annual Meeting of the International Society for Minimally Invasive Cardiac Surgery, Palais dés Congres, Paris, France, May 21-22, 1999

Address correspondence and reprint requests to: Masahiro Endo, MD, Department of Cardiovascular Surgery, The Heart Institute of Japan, Tokyo Women's Medical University, 8-1, Kawada-cho, Shinjuku-ku, Tokyo, 162-8666, Japan, Phone: +81-3-3353-8111, ext. 23111, Fax: +81-3-3356-0441

INTRODUCTION

Minimally invasive cardiac surgery (MICS) is rapidly gaining acceptance in the field of cardiac surgery. We developed two new drainage tubes specifically for MICS. In most circumstances, two drainage tubes, a retrosternal tube and a pericardial tube, and temporary pacing electrodes are inserted individually after completion of any cardiac procedure. Frequently the pleura is opened during harvesting of an internal mammary graft and then insertion of another drainage tube in the thoracic cavity becomes necessary. These new drainage tubes have cosmetic advantages since they limit the number of skin incisions.

1) Drainage tube with temporary pacing function

Since 1957, implantation of a temporary pacing electrode to control bradycardia in the postoperative period has been a routine maneuver at the end of any cardiac surgical procedure [Weirich 1957]. Also, a retrosternal drainage tube is routinely inserted into the mediastinum and a pericardial drainage tube into the pericardial cavity.

From 1968, implantation of a temporary pacing electrode for atrial and ventricular pacing has been common [Friesen 1968]. Insertion of a bipolar temporary pacing electrode is less invasive than monopolar electrodes with respect to the number of skin incisions [Duncan 1994]. There are a number of regular temporary epicardial pacing wires available for use by cardiac surgeons; the main conventional type wires are flexon type manufactured by companies such as Medtronic, Ethicon, and Davis & Geck. Because conventional pacing wires must be

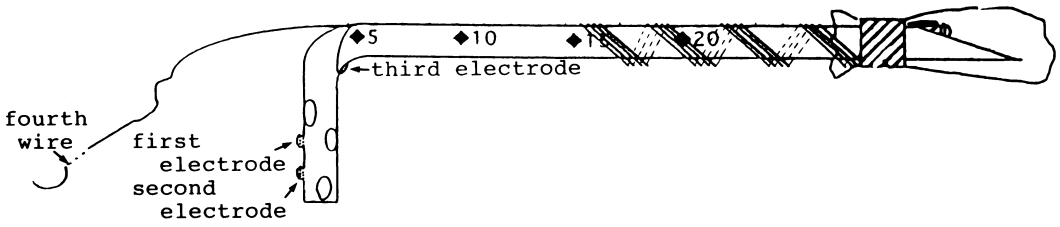

Figure 1. Design of drainage tube with temporary pacing function. The first electrode and second electrode are the positive and negative electrodes for ventricular pacing, respectively. The third electrode is the positive electrode and the fourth free wire is the negative electrode for atrial pacing, respectively.

sutured to the heart, at removal they may cause hemorrhage or late tamponade. A temporary epicardial pacing device without suturing was developed by Cardiosys Co. [Newman 1987]. However, its attachment to the heart is not satisfactory. We developed a new combined device with both drainage function and temporary pacing function [Endo 1996].

MATERIALS AND METHODS

Three fixed electrodes and one free pacing wire are incorporated in the body of an elliptical, angled 28Fr silicone drainage tube (see Figure 1 ◎). The two fixed electrodes, made of braided metal with a rectangular shape, are held in position at the side of the right ventricle. They contact the heart without causing ventricular arrhythmias and can pace the ventricle without requiring suturing. The third fixed electrode is placed subcutaneously and used as the positive electrode for atrial pacing. These wires are rolled up around the tube, and pulled out smoothly through the skin incision without damaging it. After the venous cannula in the extracorporeal circuit is removed, the fourth free pacing lead is inserted in the right atrial appendage. This wire is used as the negative lead for atrial pacing (Japanese patent #2,701,135). This drainage tube is placed in the space between the heart and the diaphragmatic pericardium (Figure 2 ◎). The drainage-pacing tube is manurfactured by Medikit Company (Tokyo, Japan).

RESULTS

The drainage-pacing device was employed in 48 coronary artery bypass grafting (CABG) patients starting in April of 1994. Drainage function was excellent in all patients. Pacing threshold (volts) and R wave sensitivity (mV) at implantation and on day 5 (at removal) were determined in the first 10 patients using a Medtronic 5375 external pacemaker-programmer with a pulse duration of 1.8±0.2 msec. Pacing threshold was 2.4±57 (1.7±3.5) volts at implantation and 5.8±7 (4.0±9.0) volts on day 5. Sensing voltage was 4.2±3 (2.2±6.3) mV at implantation and 3.8±2 (2.2±5.9) mV on day 5. The tube was removed without difficulty. No complications were observed in any of the patients.

2) Y-shape drainage tube

The pleura is frequently opened during harvesting of internal mammary grafts and rarely at the opening of the sternum using a sternal saw. In these cases, insertion of another chest tube in the thoracic cavity becomes necessary. A specialized Y-shaped drainage tube was developed to simultaneously drain both cavities.

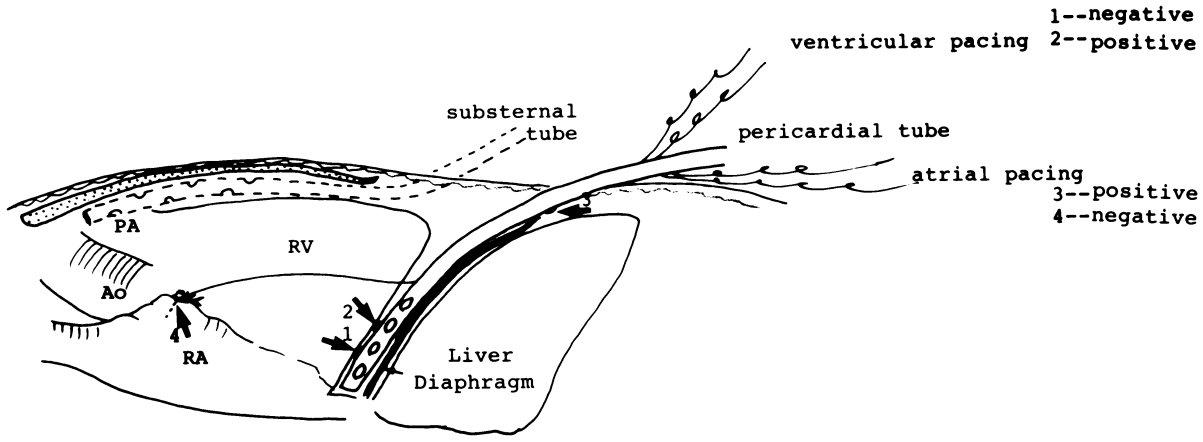

Figure 2. Design of drainage tube with temporary pacing function. The tube is placed between the diaphragm and the heart.

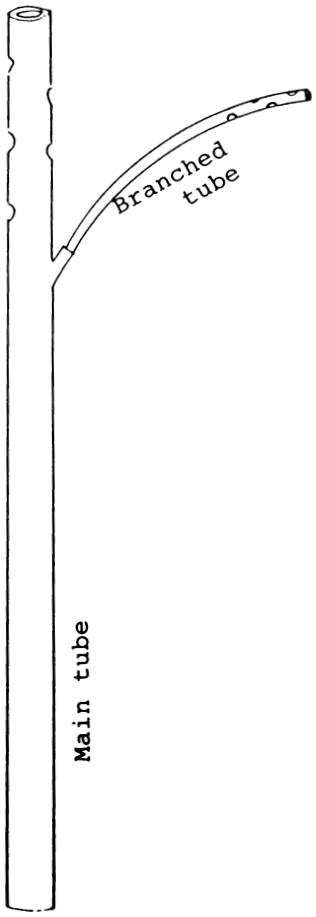

Figure 3-A. Y-shaped drainage tube. The main tube and the branched tube are connected.

MATERIALS AND METHODS

The main tube and a branched tube are connected (Figure 3-A ◎). There are two types, Y-shape 1 and Y-shape 2. The first is for a small opening in the pleura, and the second is for a large opening.

The main tube (inner diameter: 9 mm) is placed in the retrosternal or pericardial space, and the branched tube (inner diameter: Y-shape 1, 4 mm, Y-shape 2, 5.5 mm) is placed in the pleural space (see Figure 3-B ◎). Therefore, drainage from both spaces can be achieved with this single tube (Japanese Association of Intellectual Copyright #130,591). The Y-shaped tube is manufactured by Fuji Systems Corporation of Tokyo, Japan.

RESULTS

This drainage tube was employed in 34 patients. Drainage from the retrosternal space and from the thoracic cavity were equally effective. The tubes were removed with less subjective pain and without difficulty. No complications, including pneumothorax, were observed during or after removal of the tube.

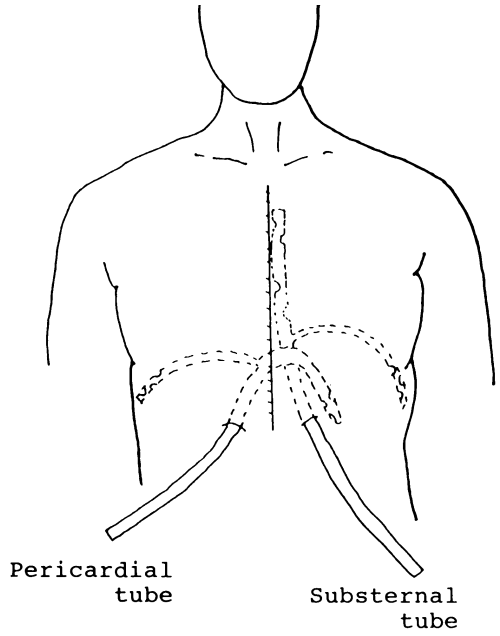

Figure 3-B. Y-shaped drainage tube. The main tubes are placed in the retrosternal space or in the pericardial space. The branched tubes are placed in the pleural space.

DISCUSSION

With minimally invasive cardiac surgery, the primary incision is smaller and more cosmetic than conventional sternotomy. The presence of separate incisions and stab wounds for insertion of pacing and drainage devices detract from the cosmetic advantages of minimally invasive cardiac surgery. We have designed two new devices to simplify the problems of inserting pacing wires and achieving wide drainage from the pericardial and pleural spaces. The first device is a combined drainage and pacing tube. The tube itself ensures apposition of the electrodes to the epicardium. We were able to achieve satisfactory pacing threshholds and sensitivity with this unit. The device is relatively contraindicated in patients who need permanent cardiac pacing and patients in whom a right gastroepiploic arterial graft is used for CABG. Before closing the sternum, the surgeon must make sure this device can be removed without difficulty.

Hagl and colleagues reported that subxyphoid insertion of a chest tube leads to significantly lower impairment of pulmonary function and less subjective pain than insertion in the intercostal position [Hagl 1999]. However, insertion of two (retrosternal and chest) drainage tubes is necessary with their method. Instead, we developed a single Y-shaped drainage tube which simultaneously drains both the pericardial and pleural spaces. Excellent drainage and freedom from complications were seen when the Y-shaped tube was used.

Our two new drainage tubes decrease skin injury, improve the cosmetic results of MICS and help simplify the implantation of needed pacing and drainage equipment despite limited access incisions.

REFERENCES

1. Duncan AJ, Predergast B. Atrial pacing and intraaortic balloon counterpulsation. Ann Thorac Surg 58:1566–7, 1994.
2. Endo M, Nakano H, Shiikawa A, Nishida H, Koyanagi H. Invention of a new drainage tube with temporary pacemaker function. Jpn J Artif Organs, 25:317–20, 1996.
3. Friesen WG, Woodson RD, Ames AW, Herr RH, Starr A, Kassebaum DG. A hemodynamic comparison of atrial and ventricular pacing in postoperative cardiac surgical patients. J Thorac Cardiovasc Surg 55:271–2, 1968.
4. Hagl C, Harringer W, Gohrbandt B, Haverich A. Site of pleural drain insertion and early postoperative pulmonary function following coronary artery bypass grafting with internal mammary artery. Chest 115:757–61, 1999.
5. Newman MA., Hodge AJ, Kallas I. Trial of a new sutureless temporary epicardial pacing device. The 4th Royal Australian College of Surgeons National General Scientific Meeting, Australia, 1987.
6. Weirich WL, Gott VL, Lillehei CW. The treatment of complete heart block by the combined use of a myocardial electrode and an artificial pacemaker. Surg Forum 8:360, 1957.