

Tentacles: A Novel Device for Exposing the Heart for the Insertion of Left Apical Assist Device Cannulae

Daniel Schmauss,¹ Ingo Kaczmarek,¹ Andrés Beiras-Fernandez,¹ Amir Khosrow Bigdeli,¹ Sandra Eifert,¹ Frank Christ,² Bruno Reichart,¹ Calin Vicol¹

Departments of ¹Cardiac Surgery and ²Anaesthesiology, Ludwig-Maximilians University, Grosshadern University Hospital, Munich, Germany



Prof. Dr. Vicol

ABSTRACT

Background: The implantation of ventricular assist devices is a well-established procedure for the treatment of imminent heart failure. The exact positioning of the left ventricular apical inflow cannula is crucial, because inflow restrictions might occur when the cannula is placed too close to the interventricular septum or a papillary muscle. We report a novel technique using the Tentacles 3-point fixation device for the exposure of the left ventricular apex during ventricular fibrillation under cardiopulmonary bypass.

Methods: We used the Tentacles, a device originally designed for positioning the heart during off-pump coronary artery bypass grafting, for implantation of a biventricular Berlin Heart Excior in a 64-year-old man. The procedure was successful and echocardiographic examinations documented the exact placement of the left ventricular cannula.

Results and Conclusion: Our new technique ensures a very precise insertion of apical cannulae, because the left ventricular shape and filling are not impaired.

INTRODUCTION

Mechanical circulatory support is a well-established and effective means to support the circulation of end-stage heart failure patients [Deng 2005]; none the less it is a complicated, invasive operation in critically ill patients, with a high rate of complications such as bleeding, infections, and thromboembolic events [Kaczmarek 2005].

In most patients the initiation of mechanical circulatory support can successfully normalize depressed cardiac output; on the other hand, the magnitude of the surgical procedure often is prohibitive [Frazier 2001].

A range of established systems are available for left- or biventricular support, such as BerlinHeart Incor and Excior, MEDOS VAD, Thoratec, Novacor, HeartMate, and the Jarvik 2000 Heart. A characteristic shared by all of these systems is that their implantation necessitates the insertion of an inflow and an

outflow cannula. For the left heart an apical cannulation is preferred by most authors [Kaczmarek 2005]. Apical cannulation strategies have been described for the left and the right ventricle [Schmid 2005]. Frazier et al. reported a nonthoracic extraperitoneal approach for left ventricular assist device implantation, a technique that might be superior in patients with previous sternotomy [Frazier 2006], whereas other authors reported that previous cardiac surgery is not a risk factor for adverse outcome after assist-device implantation [Kotschet 2005].

One of the most crucial steps in these procedures is the insertion of the inflow cannula into the left ventricular cavity. It is of outstanding importance to create free access to the left ventricular apex in order to perform the insertion as precisely as possible. This step is crucial for the short- and long-term outcome of this operation. On the one hand, placement too close to the interventricular septum might be disadvantageous owing to subsequent filling problems when negative pressure is applied to the cannula. On the other hand, placement close to the papillary muscle must be avoided, because similar suction-related filling problems might occur. This concern becomes even more important in long-term support, when the left ventricular diameter declines owing to permanent pressure relief.

We present a new technique that employs a new multisuction cardiac positioner named Tentacles (Sumimoto Bakelite Co Ltd, Tokyo, Japan) to expose the left ventricular apex for safe and highly precise insertion of the ventricular assist device cannula. We have already used the device for off-pump coronary surgery with very good results. The Tentacles device consists of 3 small silicon suction cups, each connected to an individual silicon tube with attached suction stopcock (Figure 1A). The proximal ends of these 3 tubes are connected via a 3-way connector to a single suction tube to which negative pressure of 300 mmHg is applied. The suction cups are soft and flexible so that they may gently fit the epicardial surface (Figure 1B). The suction cups can be applied to any position of the ventricular surface [Hirokuni 2006].

CASE REPORT

We performed the implantation of a biventricular Berlin Heart Excior in a 64-year-old male using the Tentacles for this procedure for the first time. This patient suffered from cardiogenic shock and imminent multiorgan failure due to dilatative cardiomyopathy.

Received November 28, 2008; accepted February 13, 2009.

Correspondence: Daniel Schmauss, Department of Cardiac Surgery, Klinikum Grosshadern, Ludwig-Maximilians-University, Marchioninstr. 15, 81377 Munich, Germany; 0049-89-70956464; fax: 0049-89-70958873 (e-mail: Daniel.Schmauss@med.uni-muenchen.de).

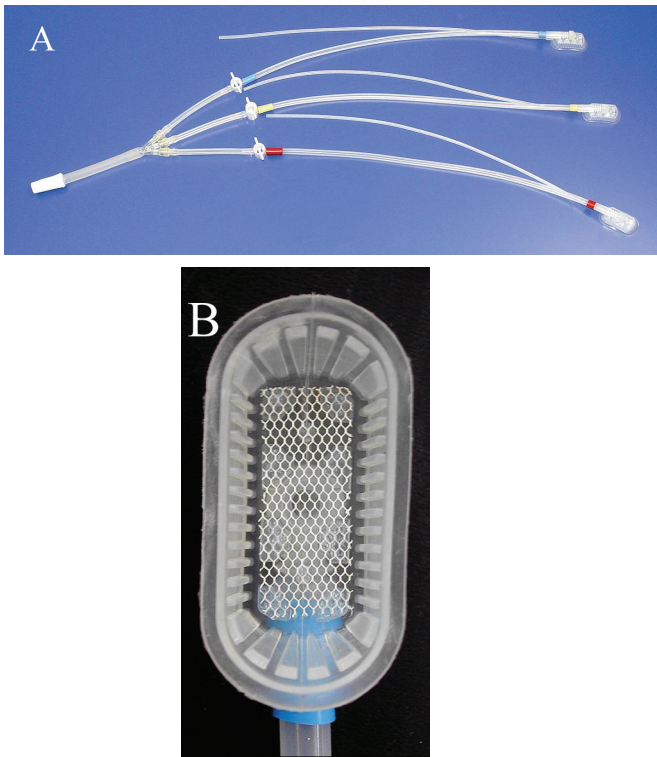


Figure 1. A, Tentacles multisuction cardiac positioner. The 3 silicon suction cups are each connected to an individual silicon tube with attached suction stopcock. The proximal ends of these 3 tubes are connected via a 3-way connector to a single suction tube to which negative pressure of 300 mmHg is applied. B, The soft and flexible suction cups can be applied to any position of the ventricular surface.

We implanted an extracorporeal, pneumatically driven biventricular assist device (Berlin Heart Excor system). After initiation of femorofemoral cardiopulmonary bypass and median sternotomy, the heart appeared remarkably enlarged. To gain free access and view the position where the inflow cannula commonly is inserted, we performed a new technique to lift the left ventricular apex and the lateral wall of the left ventricle. The Tentacles device, which provides a 3-point fixation, was positioned on the right ventricle and on the lateral and inferior walls of the left ventricle. We exposed the left ventricular apex by setting the Tentacles under traction and attaching the ends to the thorax retractor. The heart was fibrillated and filled with blood while the sutures for the apical cannula were performed. The apex cannula was inserted into the left ventricle (Figure 2). After insertion of all cannulae and connection to the Excor ventricles, cardiopulmonary bypass was stopped and mechanical circulatory support was started successfully. The postoperative course was uneventful for the first 2 weeks and at the time of this report the patient was awaiting heart transplantation. Echocardiographic examinations documented the exact placement of the left ventricular cannula (Figure 3).

DISCUSSION

Insertion of the inflow cannula into the left ventricle is a crucial step for the success and the outcome of the implantation

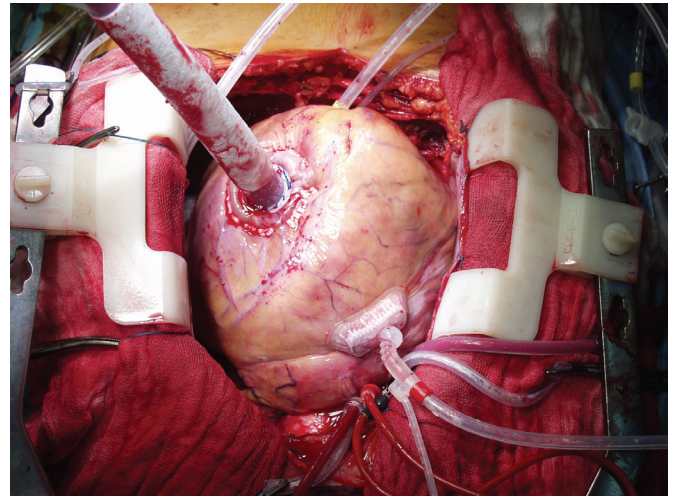


Figure 2. The Tentacles device provides a 3-point fixation on the right ventricle and on the lateral and inferior walls of the left ventricle. The exposition of the left ventricular apex by setting the tentacles under traction and attaching the ends to the thorax retractor is displayed. The heart was fibrillated and filled with blood while the sutures for the apical cannula were performed and the apex cannula was inserted into the left ventricle.

of a ventricular assist device. Most authors prefer to use apical cannulation, although complications might occur after weaning from the device [McCarthy 2000]. The choice of the correct position is of crucial importance; the cannula must be positioned neither too close to the septum nor too close to the cordae tendinae or the papillary muscles. To find the right position for the insertion of the cannula, the surgeon must ensure that the apex is exposed and lifted. Normally this is done by underlaying the heart with compresses. The disadvantage of this technique is the contusion and the anatomical alteration of the left ventricular architecture, which precludes repositioning of the heart without effort. Another way to expose the apex is the assistance of another surgeon holding the heart in his hands. The use of apical positioners

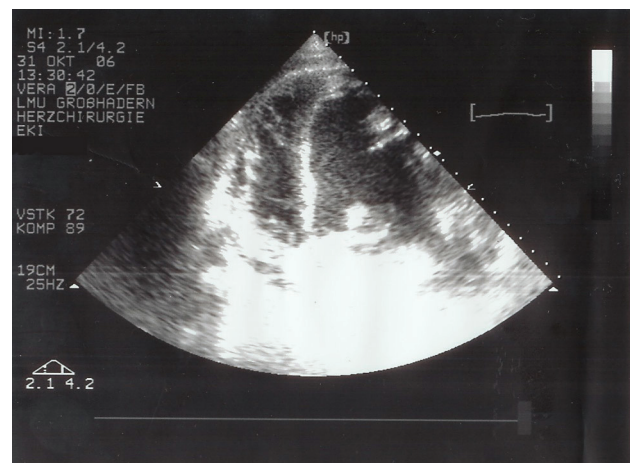


Figure 3. Echocardiogram documenting the intracavitary position of the left ventricular cannula.

such as the Medtronic Starfish (Medtronic Inc, Minneapolis, MN, USA) or the Guidant Acrobat (Guidant Corporation, St Paul, MN, USA) is not feasible for the insertion of apical cannulae.

The Tentacles device provides 3-point fixation and thereby ensures unrestricted access to the anterior wall and the apex of the left ventricle when the cannula is inserted. The left ventricle is not compressed and remains in its anatomical shape, facilitating insertion of the cannula in an optimal position. Furthermore the heart can be repositioned easily, because the position of one Tentacle arm can be changed without disattaching the other fixation points. This type of positioning of the heart is not possible with any other established instrument.

REFERENCES

- Deng MC, Edwards LB, Hertz MI, Rowe AW, Kormos RL. 2005. Mechanical circulatory support device database of the International Society for Heart and Lung Transplantation: third annual report—2005. *J Heart Lung Transplant* 24:1182-7.
- Frazier OH, Rose EA, Oz MC, et al. 2001. Left ventricular assist system multicenter clinical evaluation of the HeartMate vented electric left ventricular assist system in patients awaiting heart transplantation. *J Thorac Cardiovasc Surg* 122:1186-95.
- Frazier OH, Gregoric ID, Cohn WE. 2006. Initial experience with non-thoracic, extraperitoneal, off-pump insertion of the Jarvik 2000 Heart in patients with previous median sternotomy. *J Heart Lung Transplant* 25:499-503.
- Hirokuni A, Tomohiro M, Tomoya J, et al. 2006. A new multisuction cardiac positioner for multi-vessel off-pump coronary artery bypass grafting. *Innovations* 1:126-30.
- Kaczmarek I, Sachweh J, Groetzner J, et al. 2005. Mechanical circulatory support in pediatric patients with the MEDOS assist device. *ASAIO J* 51:498-500.
- Kotschet E, Aggarwal A, Esmore D, Kaye D. 2005. Left ventricular apical infection and rupture complicating left ventricular assist device explantation in 2 women with postpartum cardiomyopathy. *J Heart Lung Transplant* 24:350-4.
- McCarthy PM, Smedira NG. 2000. Implantable LVAD insertion in patients with previous heart surgery. *J Heart Lung Transplant* 19(8 suppl):S95-100.
- Schmid C, Scheld HH, Tjan TD. 2005. Biapical cannulation for biventricular support with the pneumatically driven Excor system. *ASAIO J* 51:126-7.