Ventricular assist device implantation in neonates: Adjustment of the BerlinHeart EXCOR arterial cannula with bovine pericardium

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In cases of terminal heart failure in neonates, implantation of an extracorporeal membrane oxygenation (ECMO) device is often considered as a first choice. Long-term support with ECMO, however, has several limitations.

Switching from ECMO to a ventricular assist device (VAD) is therefore a common option for long-term support. For neonates, however, only paracorporeal devices are feasible. In contrast to Europe such VAD systems have not been approved by the US Food and Drug Administration.

In October 2008, the German based company BerlinHeart (Berlin Heart GmbH, Berlin, Germany) received an unconditional investigational device exemption for its EXCOR Pediatric VAD system. This system, a paracorporeally placed pump, is available in pump sizes ranging from 10 to 60 mL in volume. A limitation of this system is that the suture ring of the inflexible arterial cannulas is relatively large and rigid. In neonates with a very small ascending aorta, the size and rigidity lead to difficulties in adjusting and fixing the arterial cannula with the standard technique with a small incision at the ascending aorta.

Here we describe a technique that uses bovine pericardium to adjust the aortic incision to the large inflexible suture ring for implantation of the EXCOR device in neonates.

CLINICAL SUMMARY

We report the case of a 3-month-old infant with anomalous origin of the left coronary artery from the pulmonary artery. Operative correction with transfer of the anomalous left coronary artery to the ascending aorta was performed. Unfortunately, weaning from the extracorporeal circulation was impossible as a result of low cardiac output syndrome, leading to implantation of an ECMO device. Because of impaired left ventricular function, weaning from ECMO failed within the next 3 weeks. We therefore decided to switch to a BerlinHeart EXCOR VAD system and listed the patient for cardiac transplant.

At the time of implantation, the infant weighed 5000 g and had a body length of 55 cm. Accordingly, a 10-mL blood pump was chosen.

The implantation of the apex cannula, which was 6 mm in diameter, was performed as usual with 10 U-formed stitches of 5-0 polypropylene (Prolene; Ethicon, Inc, Somerville, NJ). An arterial cannula with a diameter of 6 mm was chosen as the outflow graft; however, the ascending aorta had a diameter smaller than 5 mm. In addition, the suture ring of the arterial cannula had a diameter of 16 mm (Figure 1, A). To adjust this difference between aortic and cannula diameters, we use a simple method.

First, the suture ring was jacketed with an oval, formed bovine pericardium with a center hole diameter of 9 mm (outer diameter of the arterial cannula). This was adjusted to the tip of the cannula and sewn below the cannula ring. Four U-formed stitches with 5-0 Prolene were put through the pericardium and cannula ring (Figure 1, B). The outer border of the pericardium was sutured around the suture ring with a 5-0 Prolene continuous suture (Figure 1, C).

The 4 U-formed 4-0 Prolene sutures that had been put through the pericardium and cannula ring were then pulled and knotted. After tangential clamping of the ascending aorta, a 6-mm longitudinal incision was performed. The more flexible pericardium border could easily be sutured subsequently with the aortic incision wall with a 5-0 Prolene continuous suture (Figure 2).

With this technique, it is easy to make intraoperative adjustments to correct any size mismatch between the suture ring and the ascending aorta.

The infant has been growing normally since the procedure (current weight 8 kg, current height 90 cm). He has had the device for 1 year now and is awaiting cardiac transplant.

DISCUSSION

A major problem of infants awaiting transplants is their high mortality. According to the United Network for Organ Sharing, of the more than 1600 infants added to the heart or heart–lung transplant lists during the last decade, fewer than 50% received donor organs.

In addition, assist devices are of significant importance in the growing field of end-stage heart failure in the pediatric
population, with its longer waiting times for cardiac transplant.

Unfortunately, availability of assist devices for pediatric use and especially for neonates is limited. Recognizing this caveat, in 2005 the National Heart, Lung, and Blood Institute solicited proposals for the development of novel circulatory support systems for pediatric patients with congenital or acquired cardiovascular disease. Before full Food and Drug Administration approval, some devices can only be used in a compassionate use situation under investigational device exemption. The BerlinHeart EXCOR Pediatric VAD system has had such investigational device exemption since October 2008.

Especially in neonates, implantation of the arterial cannula into a small ascending aorta can be difficult because of the large and rigid suture ring. The technique described here is a feasible and practical option for this situation. It could be chosen intraoperatively, in particular if the center does not have enough pediatric cannulas in stock.

References