1

DEVELOPMENT OF ELECTROHYDRAULIC TOTALLY IMPLANTABLE ARTIFICIAL HEART AT THE NATIONAL CARDIOVASCULAR CENTER OF JAPAN

National Cardiovascular Center, Osaka, Japan
Y.Taenaka, T.masuzawa, E.Tatsumi, K.Araki, T.Nakatani, H.Akagi, Y.H.Park, H.Takano

Two types of devices have been developed as electric totally implantable artificial hearts at the National cardiovascular Center. One is an electrohydraulic total artificial heart(EHTAH) and the other is an implantable centrifugal pump(CP) for chronic use.

The EHTAH consists of elliptical-shaped right and left diaphragm-type ventricles of 90 ml in stroke volume and a separately-placed friction pump of Φ73 mm X 3.3 mm as an electrohydraulic actuator connected with 2 fexible stainless tubes of Φ10 mm in I.D.. Silicone oil flows back and forth through the tubes to drive the blood pumps alteernately. Possible good characteristics of the EHTAH are suitable anatomical fitting even in a small-sized recipient and realization of an easy surgical implatation procedure like that for a pneumatic system. The purpose of this study is to prove these features in acute animal experiments. The EHTAH was implanted orthotopically in 2 goats of 50 and 49 kg through right thoracotomy and under cardiopulmonary bypass. The right and left pump were handled independently by virtue of the flexible tubes to make the coupling of the pump with connectors easy and to choose a suitable placement of the blood pumps. The cardiopulmonary bypass time was 115 min and 105 min, respectively. Hemodynamic parameters were maintained within normal range with the EHTAH. This device could be implanted into smaller-sized animals with a similar surgical procedure to that for a pneumatic system and fit adequately without compromising its hemodynamic performances.

Two recent models of the CP were evaluated in antithrombogenicity and hemolytic properties. In our CP made of polypropylene and acrylic resin, Φ63 mm X 106 mm in size with a DC motor, an impeller with vanes on a column and a central tunnel spins on a thrust holder by magnetic coupling with a magnet outside the blood chamber. The pump has no seal around the rotating part nor a shaft and blood irrigates the gap between the column and the housing continuously. The older type NCVC-0, has 4 curved and flat vanes and the new one, NCVC-1, has 6 curved and triangular vanes. Hemolytic properties were evaluated in an in vitro study in which our pumps and Biopump^R were driven in closed circuits fixed with fresh heparinized goat blood at 5 L/min of flow and 120 mmHg of head. Hemolytic indices of NCVC-0, NCVC-1 and Biopump^R were 0.029, 0.009 and 0.007, respectively. Six NCVC-0s were installed in goats with body weight of 55-75 kg as a paracorporeal left heart bypass(LHB) and the flow rates were controlled to be around 4-5 L/min. Oral antiplatelet agent, 30 mg/kg/day of cilostazol, was administered. All the pumps could run for more than 2 weeks and 2 were driven for more than a month. The pumps were free from thrombi except for fabrication defects such as flaws at injection molding ports. One NCVC-1 was also implanted in a goat of 50 kg as an LHB. When the CP was installed, heparin was used, but no anticoagulant nor antiplatelet drug was given thereafter. The pump was driven for 80 days. The recent 2 models of our CP showed good antithrombogenicity and the newest model, NCVC-1, realized a lower hemolysis rate. These results support the feassibility of a CP as a chronic device.