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IN VIVO EXPERIENCE OF ELECTROHYDRAULIC VENTRICULAR ASSIST DEVICE

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An electrohydraulic ventricular assist device (EVAD) developed by Seoul National University consists of a blood pump, a pressure pump and a control and monitoring unit (CMU). The volume of a polyurethane blood sac inside the blood pump is 50 ml and the outer housing containing the ventricle is made of a transparent acryl that is dimension of 90 mm x 65 mm x 115 mm. A Bjork-Shiley valve with annulus I.D. of 21 mm, is used at the inflow port and a polymer valve is used at the outflow port, respectively. A ball screw in the pressure pump converts rotary motion of DC motor to rectilinear motion of a polyurethane bellows. The major components of the CMU are a micro-controller based controlling unit, a motor driving unit and a PC. PC, as a control panel, accepts control orders of EVAD perfusionist and sends orders to the micro-controller. The CMU controls systolic velocity, diastolic velocity and stroke length. The SD ratio, which means fractional ratio of systolic period to diastolic period, can be changed according to the systolic and diastolic velocities.

Special concern has been given to the low preload condition, which might cause a critical obstruction in the drainage cannula. The CMU is programmed to detect the changes in diastolic current waveforms occurred in the low preload state. So EVAD can provide preload-sensitive assist volume regulation by adjusting the pump rate while maintaining full-fill and full-empty operation.

The detection capability of the CMU for the low preload state was checked using a newly designed mock circulation system. The mock circulation system has 3 chambers; a left atrial chamber, an aortic chamber and a hydrostatic pressure chamber for a venous reservoir. Test fluid from hydrostatic pressure chamber passes the left atrial chamber and the EVAD which pumps fluid into the aortic chamber.

In *in vitro* test on the mock circulation setup, the EVAD delivered a maximum output of 4.0 L/min against the high afterload of 125 mmHg. It also operated in full-fill and full-empty mode even under the low preload (LAP<5 mmHg) condition. *In vivo* trials were performed using four dogs and a sheep. The longest survival record was 5 days. In animal experiments, the EVAD was operated in a synchronous mode from 1:1 to 3:1 rate with the heart rate of animals.

In conclusion, the developed EVAD provides a regulated volume assistance in a synchronous mode and it is very promising to use this system for clinical application.