EVALUATION OF MECHANICAL SEALS FOR CENTRIFUGAL BLOOD PUMPS BY CHRONIC ANIMAL EXPERIMENTS

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INTRODUCTION

Centrifugal blood pumps have many advantages when compared to pulsatile pump. However, shaft seal problems have been the most crucial issue in the development of implantable centrifugal blood pumps for many years. Recently, we developed the mechanical seal incorporates a recirculating cool seal system as a practical solution to the shaft seal problem. Authors have already clarified the shaft sealing performance of the mechanical seal [1]. However, these experiments were carried out in short term (within 6 hours) and done in vitro experiments. The objective of this study is to experimentally evaluate the sealing performance of the mechanical seal by chronic animal experiments.

MATERIALS

Figure 1 shows a schematic cross section of the centrifugal blood pump. The cooling water is introduced into the motor case through a cooling water inflow port and then returns to an outflow port. The cooling water is recirculated between the blood pump and an extra-corporeal cooling water reservoir through a cooling water tube by a roller pump.

The mechanical seal is constructed of a carbon graphite seal ring and a silicon carbide (SiC) ceramics seat ring. The seal ring is rotated with the shaft while the seat ring is stationary. The blood and the cooling water are separated at the sliding surface. The outer and the inner diameter of the seal face is 10 mm and 7 mm respectively. The surface roughness of the seal ring and the seat ring is 0.25 µm and 0.20 µm respectively.

EXPERIMENTAL PROCEDURES

As shown in Figure 2, the centrifugal blood pump was implanted in calves. Pump speed was controlled at approximately 3000 rpm by a blood pump controller.

The leakage rate of plasma into the cooling water through the mechanical seal was measured by monitoring the infiltration of sodium ions from bovine blood. The cooling water samples were taken every 2 weeks, and the concentration of sodium ion was measured by inductively coupled plasma (ICP) light emission analysis to detect blood element contamination.

The leakage rate of the cooling water into the blood through the mechanical seal was determined by measuring the fluid level at the reservoir of the cooling water periodically.

RESULTS

The centrifugal blood pump was implanted in calf over a period of 153 day. In vivo evaluation of the mechanical seal for the centrifugal blood pump has demonstrated good seal capability throughout the experiment. The leakage rate of plasma was less than 0.025 ml/day. The consumption rate of the cooling water was less than 0.5 ml/day.

CONCLUSIONS

The mechanical seal performed acceptably well to support the use of this centrifugal blood pump for a chronic application.

REFERENCES