A new-generation ventricular assist system

Artificial heart to be commercialized: a “mono-pivot circulatory assist pump”

The monopivot centrifugal pump developed by AIST is a circulatory assist pump that can be used for about 2 weeks. The 50 mm-centrifugal impeller of the pump is supported by a pivot bearing at one end and a magnetic bearing at the other. Since destruction of the blood cells, blood coagulation (thrombus), and material wear concentrate to the pivot bearing, flow visualization and animal tests are performed as countermeasures for thrombus formation and material for artificial hip joints is used against material wear. In the flow visualization a high-speed video and a continuous laser light sheet (Fig. 1) are used in addition to the animal tests to prevent thrombus formation. The local shear stress and secondary flow in the spatial gap are evaluated intensively to shorten the period for design improvement.

A next-generation “ventricular assist pump with an impeller levitated with a hydrodynamic bearing”

Moreover, AIST is developing an implantable artificial heart for the next generation with a lifetime over 5 years (Fig 2). The ventricular assist pump is shown in Fig 3. A groove of 30 µm in depth is curved on in the surface of the hydrodynamic bearing whose local pressure lifts up the impeller by approximately 20 µm. To evaluate the blood cell destruction and coagulation in the bearing gap, computational fluid dynamic analysis was conducted to determine the design. The bearing gap was expanded by adjusting the pressure distribution to reduce the destruction of blood cells. In a hemolysis test using animal blood, destruction was reduced to a tolerable level. In addition, the shape of the bearing groove was modified to increase the flow through the bearing. It was found in thrombus testing using fresh animal blood that thrombus formation in the bearing was almost eliminated. Comparative studies were performed for the titanium alloys used on the surfaces contacting the blood and for different surface processing techniques. We hope we will be able to perform animal studies of this ventricular assist system in the near future.

Monopivot circulatory assist pump

One-week antithrombogenic tests repeated around 20 times in the left ventricular bypass configuration with sheep and confirmed no thrombus formation. This pump is now being developed as a circulatory assist pump by a medical device manufacturer to make it a product within 2 years.

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