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WHIRLING MOTION OF THE IMPELLER OF A CENTRIFUGAL PUMP AS A VENTRICULAR ASSIST DEVICE

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ABSTRACT

Compact centrifugal pumps have recently used as left ventricular assist devices (LVADs), which support the pumping function of the native heart of a patient with severe heart failure. Noncontact bearing systems, such as magnetic levitation or hydrodynamic bearings, are usually employed for these pumps in order to avoid blood coagulation at the stagnant regions inside the pump. These bearing systems, however, due to the limitation of available power input, do not possess such sufficient rigidity that the standard operational conditions usually exceeds their critical speeds. There are possibilities when the whirling motion of the impeller causes instability of the impeller suspension system. Our research group has been developing a centrifugal blood pump for long-term use, and has found that the impeller can mechanically contact the casing wall at particular operational conditions in the course of animal experiments for evaluation of the pump. In the present study, we conducted measurements of the radial displacement of the impeller of the centrifugal blood pump which our research group developed, and investigated the effect of the whirling motion of the impeller on the stability of the impeller positions. Computational fluid dynamics approach were also used to investigate the fluid force acting on the impeller. The experimental results indicated that the system fell into an unstable status when the ratio of the whirling motion to the rotational speed of the impeller coincided with 0.5. The averaged direction of the radial fluid force could be estimated, which qualitically agreed with the numerical results.