Unique ECG Finding in a Patient With an Axial Blood Flow Pump

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After implanting a permanent Jarvik 2000 Heart (Jarvik Heart, Inc) in a patient with end-stage heart failure (Figure 1), we simultaneously recorded ECG and Doppler flow velocity in the vascular graft that connects the blood pump and descending aorta. With the pump temporarily switched off, the graft blood flow reversed, passing from the descending aorta through the device to the left ventricle. The peak systolic flow velocity in the graft decreased from 120 to 15 cm/s, and diastolic regurgitant flow developed at 30 cm/s. These changes in graft flow velocity completely reversed within 6 cardiac cycles after the pump had been switched on again (Figure 2). With the pump operational, artifacts were present on ECG throughout the cardiac cycle (Figure 3A). When the pump was switched off, a reverberating wave was present only from the end of the T wave to the onset of QRS complex (Figure 3B).

We attribute the reverberating wave during regurgitant graft flow to electrical current generated by reversed spinning of the impeller within its electromagnet housing. This unique ECG provides an opportunity to substantiate or rule out the possibility of thrombotic binding of the impeller in the event of device malfunction.

Figure 1. Plain chest x-ray showing the Jarvik 2000 device in the apex of the left ventricle and the permanent power cable (via skull-mounted pedestal). A vascular graft joins the pump to the descending thoracic aorta.
Figure 2. Flow velocity was recorded in the vascular graft using pulse Doppler. The peak flow velocity with the pump switched on was 110 to 120 cm/s. It dropped to ~20 cm/s immediately after the pump was switched off. Subsequently, there was significant diastolic flow reversal with a velocity ranging from 20 to 30 cm/s. This regurgitant flow disappeared rapidly after the pump was switched on again, and the peak forward-flow velocity accelerated to 100 cm/s after 6 cardiac cycles.

Figure 3. Leads I, II, III, aVR, aVL, and aVF of a standard surface ECG were recorded at a speed of 100 mm/s with the Jarvik 2000 pump switched on (A) (10 mm/mV) and then off (B) (20 mm/mV). There was artifact throughout the cardiac cycle when the device was operational. With the pump off, however, reverberating artifact occurred only during diastole and with lower frequency and amplitude.
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