Anesthesia and basic instrumentation

Premedication consisted of atropine (1.0 mg), diazepam (10 mg), and ketamine (20 mg/kg), administered i.m. via a butterfly cannula in the neck, and further mask ventilation for a short period with 3% isoflurane in oxygen. Intravenous access was ensured via cannulation of two ear veins for infusion of fluids and anesthetic drugs. Intravenous anesthesia was induced by loading doses of midazolam 0.3 mg/kg, fentanyl 0.02 mg/kg and sodium pentobarbital 15 mg/kg, and maintained throughout the experiment with a continuous infusion of midazolam 0.3 mg/kg/h, fentanyl 0.02 mg/kg/h, and sodium pentobarbital 4 mg/kg/h. After tracheostomy and intubation, animals were mechanically ventilated with 56% nitrous oxide and oxygen (Julian, Drägerwerk, Lübeck, Germany). Basic liquid substitution was Ringer’s acetate with 20 mmol/l of potassium chloride (KCl) added, administered at 15 ml/kg/h i.v. (21). To prevent hypoglycemia after fasting, the intravenous anesthetic drugs were mixed with 5% glucose rather than with Ringer acetate for the first hour during instrumentation. Animals were continuously monitored with ECG, pulse oximetry, rectal temperature and etCO$_2$ as recorded from the ventilator.

A supra-pubic urinary bladder catheter was inserted surgically, and a 5F cannula (Radifocus Introducer II, Terumo, Leuven, Belgium) was placed in the left jugular vein for extra fluid infusion during the induced cardiac arrest. With a semi-percutaneous approach, vascular sheaths were placed in both groins by surgical incisions down to the muscular layer to facilitate palpation and sheath introduction. After placing a 6F sheath in the right femoral artery, 5000 IE units of Heparine was given and was repeated by the hour. Arterial blood samples were drawn including acid-base measurements (ABL800Flex, Radiometer Medical ApS, Brønshøj, Denmark) before further preparation and cannulation. Sheaths were then inserted in the right femoral vein (8F), left femoral artery (6F) and left femoral vein (6F). A pigtail catheter was inserted into the left ventricle through the right femoral artery for injection of fluorescent microspheres (Dye-Trak "F"; Triton technology Inc, San Diego, CA). Pressures in the left ventricle, the abdominal aorta and the inferior caval vein were measured.
(TruWave®, Edwards Lifesciences, Irvine, CA). All variables were continuously recorded and digitized (ACQ-7700, Data Sciences International (DSI), St. Paul, MN).

The arterial sheath in the left femoral artery was exchanged after predilatation with a 16F Cook sheath (Cook Medical Inc., Bloomington, IN) in both groups. In the BIVAD group the 6F sheath in the left femoral vein was exchanged over an Amplatz super stiff wire (Cook Medical Inc., Bloomington, IN) to a 300 mm long 24F High Quality Sealing sheath, (Alseal, Besançon, France) after predilatation. In the LVAD group this sheath exchange was omitted.

**LVAD and RVAD placement**

A Schwann-Ganz catheter was floated into the pulmonary artery bifurcation through the 24F venous access under fluoroscopic guidance. Through the lumen of this catheter a 0.25" Amplatz super stiff wire (Cook Medical Inc, Bloomington, IN) was placed in the right pulmonary artery over which the Impella RP was introduced under fluoroscopic guidance. After calibration of the hemodynamics sensor in the inferior caval vein/right atrium, the final RVAD position was guided and verified by Intracardiac Echocardiography (ICE) (ACUNAV 8F, Siemens Healthcare GmbH, Erlangen, Germany and Vivid q, GE Vingmed Ultrasound, Horten, Norway) and fluoroscopy so that the inlet of the RVAD was in the transition between the inferior caval vein and the right atrium, and the outflow was over the pulmonary valve (Supplemental Figure 1B). We found that ICE images of the pulmonary valve could best be achieved from the aorta, and could confirm the continuous flow of the Impella RP with Doppler (Continuous wave and color). Irrespective of randomization, but subsequent to RVAD deployment in the BIVAD group, the Impella CP was placed over a 0.013" 300 mm wire with the inlet in the left ventricular apex and the outflow in
the ascending aorta. When in place, both pumps were started at lowest possible flow output (P1) to prevent thrombus formation.

**Statistical analysis**

Statistical calculations were done using IBM SPSS Statistics software (v. 23, IBM, Armonk, NY). Data are expressed as the mean ± standard error of the mean or median (25%; 75%) unless otherwise stated. Baseline variables were compared by two-sample Student's t-test on data with normal distribution and with Wilcoxon–Mann–Whitney U-test on ranks if the Kolmogorov–Smirnov test or the Levene equal variance tests were significant. Wilcoxon–Mann–Whitney U-tests were used to compare myocardial blood flow rates between groups after induction of VF.

Hemodynamic and other continuous variables during VF were compared by two-way analysis of variance for repeated measurements (RM-ANOVA) with BIVAD vs. LVAD as grouping factor ($p_g$) and time as within-factor ($p_w$). If Mauchly's test of sphericity was significant ($p < 0.05$), the Greenhouse–Geisser adjustment of degrees of freedom was selected for the evaluation of main effects and interaction. A significant interaction ($p_i < 0.10$) justified new ANOVAs on simple main effects followed by post hoc comparisons of individual means with Neumann–Keuls multiple contrast tests when justified by the preceding ANOVA. Simple linear regression analysis was used to evaluate the relationship between pressure gradients and myocardial blood flow rates. Fisher's exact test was employed to compare categorical variables. Except for the interaction effect in the RM-ANOVA, a significant difference was noted when $p < 0.05$. 