# Initial analysis of biventricular cardiac function in preterm neonates using MR imaging at 3.0T

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**Background:** Despite the importance of circulatory factors in determining outcome following premature birth, currently available clinical methods for assessing cardiac output are poor[1]. Cardiac magnetic resonance (MR) imaging is becoming the mainstay of assessment of cardiac function in adults, but has not been assessed for examination of preterm infants. Cardiac MR measurements of ventricular output in adults may be limited by partial volume effects at the inferior wall[2] or by through-plane motion of the atrio-ventricular (AV) valves[3] and it is not known if this leads to poor reproducibility of measurements in the smaller preterm heart. In this study we explored cardiac MRI of preterm infants using a 3T scanner, which was chosen because higher field strength has potential advantages when imaging smaller objects.

**Aims:** To describe preliminary normative values for left ventricular output (LVO) and right ventricular output (RVO) in stable preterm neonates and to assess the reproducibility of LVO and RVO measurements in the preterm population, by comparing assessment of RVO when measured in the axial and short axis planes, with and without compensation for AV valve motion.

**Methods:** The study was approved by the local regional ethics committee, and written informed parental consent was obtained in all cases. Infants were scanned without sedation, and heart rate and oxygen saturation were monitored by a neonatologist throughout the scan. Imaging was carried out using a Philips 3.0 Tesla Achieva system (Best, Netherlands) with VCG gating but without respiratory compensation. After some experimentation, balanced fast field echo (bFFE) sequences were used with TR 4ms, TE 2ms, flip angle $45^0$, FOV 220mm, matrix 144/256, 32 phases per cardiac cycle. Axial and short axis stacks were acquired containing the volumes of both ventricles, with slice thickness 3-5mm, slice gap 0.3-0.5mm, requiring 4-8 slices per stack.

**Analysis:** Ventricular volumes were assessed by tracing the endocardial borders at end-diastole and end-systole in each slice. LV short axis volumes were assessed using specialist software which allows modelling of the endocardial border and tracking of the AV valve plane through the cardiac cycle (CMR Tools, Cardiovascular Imaging Solutions Limited, London) (Figure 1). RV short axis volumes were assessed using this same software. RV volumes were also assessed in the axial and short axis planes without compensation for AV valve motion.

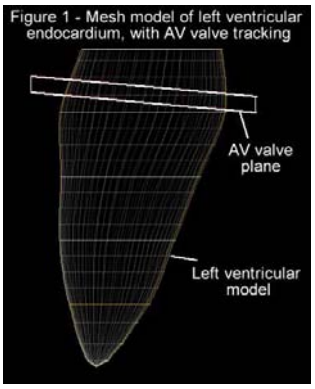
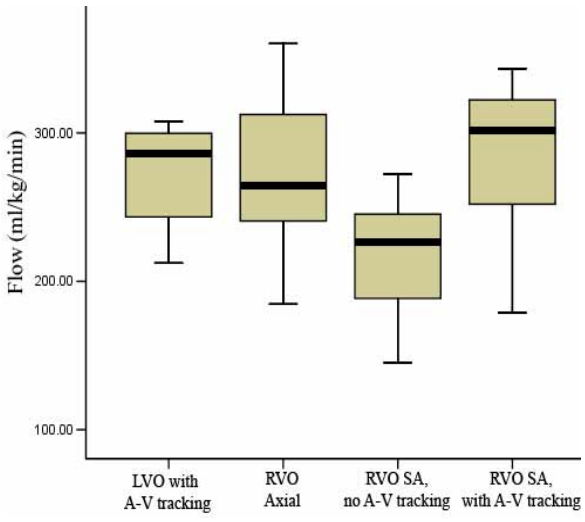


Figure 1 - Mesh model of left ventricular endocardium, with AV valve tracking

***Results:*** Fourteen infants without clinical evidence of a patent ductus arteriosus were studied. Median (range) gestational age at birth was 31 (29–38) weeks, with birth weight 1489 (875–2256) grams. Corrected gestational age and weight at time of MRI were 34 (32–42) weeks and 1630 (1000–4600) grams. Median (range) LVO in this cohort was 285 (212-396) ml/kg/minute (Boxplot, single outlier at LVO 396 ml/kg/min not shown). LVO (in ml/kg/min) did not change from 32-40 weeks gestation.

When analysed in the axial plane the median (range) RVO was 265 (185-360) ml/kg/min. When analysed in the short axis plane without A-V valve tracking RVO was consistently underestimated: median (range) 227 (145-272) ml/kg/min. When analysed in the short axis plane with A-V valve tracking RVO values were similar to those seen in the axial plane and to values for LVO: median (range) 291 (179-449) ml/kg/min (Boxplot, single outlier at RVO 449 ml/kg/min not shown).




***Conclusion:*** Cardiac imaging of preterm neonates at 3T was successfully achieved in this patient group. Median LVO and RVO in stable infants at 32-42 weeks gestation are around 270-290 ml/kg/min and do not appear to change with growth. In preterm infants assessments of RVO in the axial plane or in the short axis plane with AV valve tracking give values which are relatively consistent with each other and with LVO. Assessment of RVO in the short axis plane without AV valve tracking appears to underestimate RVO compared to other methods. This preliminary data suggests that functional cardiac imaging can be a viable tool for the study of preterm infants. Further work will be required to confirm normal ranges and reproducibility.

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