

Novel combined 'Cardiac Catheterization-Magnetic Resonance Imaging' (XMR) under dobutamine stress for cardiovascular assessment in children prior to liver transplant

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Background: Congenital heart disease is common in children with cholestatic liver disease and has been associated with higher liver transplantation (LT) mortality. Pre-LT cardiovascular assessment to evaluate right heart obstructions and increase in the cardiac index during pharmacological stress can be performed by echocardiography or cardiac catheterization, but at the expense of several limitations and assumptions. We present a novel combined **cardiac catheterization-magnetic resonance** imaging technique (**XMR**) using dobutamine-stress for cardiovascular assessment in children considered for LT.

Methods: Fourteen children (mean 4.5 years, range 8 months-15 years) with advanced liver disease underwent nineteen XMR investigations. The protocol included (1) anterograde fluoroscopic cardiac catheterization to assess pressures in the right ventricle (RV) and pulmonary arteries (PA) and (2) magnetic-resonance imaging to assess the cardiovascular morphology and measure flows in the great vessels to allow calculation of vascular resistance and cardiac index at rest and during two further stage dobutamine stress ($10\mu\text{g}/\text{kg}/\text{min}$ and $20\mu\text{g}/\text{kg}/\text{min}$).

Results: XMR was completed successfully in all nineteen investigations. During maximal dobutamine stress ($20\mu\text{g}/\text{kg}/\text{min}$), there was a significant increase ($p<0.05$) in the mean heart rate (+54%), RV systolic pressure (+60%), mean PA (+31%), mean femoral artery (FA)(+20%), RV/FA ratio(+25%) and cardiac index(+45%) as shown in *Table 1*. Patients with baseline elevation of their cardiac index $>4.3\text{ l}/\text{min}/\text{m}^2$ (*Figure 1*) were less likely to further raise the cardiac index above the previously recommended threshold of $>40\%$ (sensitivity 89%, specificity 90%). Of these three were found suitable for LT. The mean X-ray radiation screening time was 8 minutes and radiation dose $2.22\text{ Gy}\cdot\text{cm}^2$ (below 90% of the reported conventional radiation exposure). Seven patients underwent successful LT, two are still listed awaiting LT, three were removed from the waiting list due to their improved liver condition and two died awaiting LT.

Conclusions: We propose a new dobutamine-stress XMR protocol for pre-LT cardiovascular assessment, which is feasible, safe and has lower radiation dose than traditional methods. It allows morphology delineation, accurate haemodynamic calculations and evaluation of the cardiac reserve. Previous cardiac index thresholds of a 40% increase during stress may not apply to patients that are already in a hyperdynamic rest state.

	Rest	Dobutamine 10 $\mu\text{g}/\text{kg}/\text{min}$	Dobutamine 20 $\mu\text{g}/\text{kg}/\text{min}$
Heart rate (bpm)	89 (15)	103 (15)	129 (18)
Cardiac index ($\text{l}/\text{min}/\text{m}^2$)	4.3 (1.3)	5.5 (1.5)	6.0 (1.4)
RV systolic pressure (mmHg)	40.9 (11.5)	56.3 (21.2)	65.5 (27.9)
Mean PA pressure (mmHg)	20.3 (4.4)	25.4 (6.2)	26.6 (11.2)
Mean FA Pressure (mmHg)	55.4 (12.7)	66.2 (13.6)	66.6 (15.4)
Ratio RV/FA	0.52 (0.18)	0.55 (0.24)	0.65 (0.26)

Table1. Haemodynamic changes at rest and at dobutamine stress (10 and 20 $\mu\text{g}/\text{kg}/\text{min}$) expressed as mean and (standard deviation).

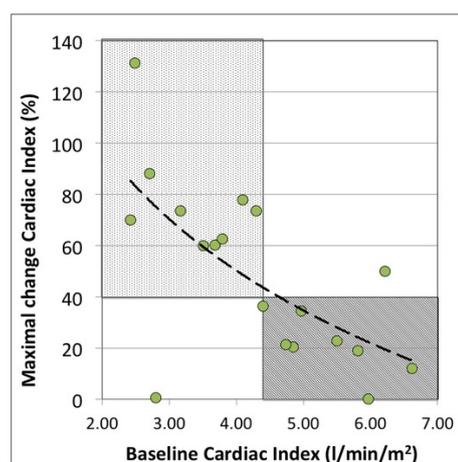


Figure 1. Scatter-plot graph. Maximal change in Cardiac Index (%) during dobutamine stress compared with the baseline cardiac index at rest.