

Vulnerability of Coronary Circulation after Norwood Type Operation

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BACKGROUND: Surgically reconstructed aorta after Norwood (ND) type operation can be stiff and hence associated with reduced aortic reservoir function. This could in turn adversely affect coronary perfusion and thereby induce right ventricular (RV) dysfunction, which is often observed after the ND procedure. We hypothesized that ND operation leads to a reduction in subendocardial coronary perfusion due to its hemodynamic characteristics and that the impaired coronary perfusion is associated with poor outcome after this procedure.

METHODS: We studied 29 consecutive patients who had undergone ND operation and RV-PA shunt. The subendocardial viability ratio (SEVR: Buckberg index), a marker of subendocardial ischemia, was calculated as time tension index divided by diastolic pressure time index, using the ascending aortic pressure waveform recorded during cardiac catheterization. Data were compared to those in 31 control subjects who had VSD or PDA with negligible shunt flow.

RESULTS: The mean SEVR of ND patients was significantly lower than that of the controls (0.71 ± 0.21 vs. 1.04 ± 0.24 , mean \pm SD, $p < 0.001$). The mean ascending aortic stiffness was significantly higher in ND patients than in the controls. Importantly, the SEVR in ND patients with poor outcome (defined as death, progressive atrio-ventricular regurgitation, or severe symptomatic heart failure) was significantly lower than that in the remaining ND patients (0.62 ± 0.04 vs. 0.82 ± 0.05 , $p < 0.01$). In addition, the lower SEVR in ND patients correlated significantly with higher circulating levels of BNP, angiotensin and aldosterone ($p < 0.01$, each). In this study, cardiac index, Qp/Qs, and the anatomical feature of the native aorta, have no correlation with SEVR. Multivariate regression analysis showed that increased aortic stiffness, faster heart rates and severity of residual aortic arch stenosis (% stenosis compared to descending aorta) correlated significantly with the lower SEVR ($p = 0.018$, 0.011 , 0.008 , respectively).
CONCLUSIONS: There is high risk of reduced coronary perfusion after ND operation due to increased aortic stiffness and abnormal morphology of the reconstructed aorta and vulnerability to tachycardia. These results emphasize the importance of the surgical design of the re-constructed aortic arch, and highlight the importance of rate-control in the postoperative management of patients with ND operation.