The Use of High-Frequency Jet Ventilation in the Management of a Pre-term Infant with Pulmonary Stenosis and Respiratory Distress Syndrome. – A Case Report

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INTRODUCTION: The combination of congenital heart disease (CHD) and respiratory distress syndrome (RDS) can present a difficult scenario to manage with conventional mechanical ventilation (CMV). Our patient presented with poor right ventricular (RV) function, and refractory respiratory failure on CMV. High-frequency jet ventilation (HFJV) was used in order to improve ventilation at a similar or lower mean airway pressure (P_{aw}) compared to CMV.

CASE: This patient was a 3.2kg male infant born at 33 WGA. The infant was intubated within the first 10 minutes of life for apnea. The chest radiograph was consistent with respiratory distress syndrome (RDS). A postnatal diagnosis of valvar pulmonary stenosis with supra-systemic RV pressures was confirmed via echocardiogram. The following day he was brought to the cardiac catheterization lab where he underwent a balloon dilation of the pulmonary valve. During the catheterization, ventilation became problematic, resulting in pH of 7.10 and $PaCO_2$ 88-95 for the duration of the procedure. Additionally, the procedure was complicated by multiple runs of tachycardia, and hypotension.

Following the catheterization, he was returned to our cardiac intensive care unit (CICU) and placed on PC-SIMV. On a P_IP of 30 cmH_2O, PEEP of 4 cmH_2O and 40 breaths per minute (b/min), F_iO_2 60%, he had poor chest excursion and tidal volumes of 4 cc/kg. The follow up ABG revealed persistent respiratory acidosis, pH 7.10 $PaCO_2$ 95 PaO_2 52. HFJV was initiated with a P_IP of 40, frequency of 420 b/min and 0.02 s on-time. The CMV settings were adjusted to PIP 30 cmH_2O PEEP 8 cmH_2O and 5 b/min, which maintained the pre-HFJV P_{aw} of 13 cmH_20. An hour later his pH had increased to 7.39 with a $PaCO_2$ of 40. CMV and HFJV settings were reduced over the next 4 hours, decreasing the monitored P_{aw} to 10 cmH_20.

DISCUSSION: High-frequency oscillatory ventilation (HFOV) is a frontline therapy for neonatal RDS, however there has been conflicting evidence regarding improvement in outcome. The active expiratory phase during HFOV often requires a higher P_{aw} relative to amplitude in order to prevent dynamic airway collapse and atelectasis. Limiting the effect of P_{aw} on hemodynamics is especially important in infants with CHD and RV dysfunction. HFJV has been shown to improve ventilation and oxygenation with potentially less effect on cardiopulmonary interactions in infants following cardiac surgery. Meliones concluded that HFJV significantly reduced P_{aw} with a concomitant increase in cardiac output following Fontan completion. These changes may be attributed to a reduction of intrathoracic pressure, pulmonary vascular resistance, and improved venous return. In this case we optimized our ventilation strategy to minimize barotrauma, limit P_{aw}, and maintain normal pH. HFJV is a viable option for children with CHD following cardiac surgery and procedures, and may improve heart function by providing adequate ventilation at a lower P_{aw} than CMV or HFOV.