HFOV with prone ventilation in pediatric severe ARDS, a case series from a tertiary care hospital

Prashant Rajebhosale1, Dhwani Shah2, Pooja Agrawal3
1Paediatric intensivist, 2Junior resident, 3Neonatologist, Aditya Birla Memorial Hospital, Pune, Maharashtra, India
Received: 20-May-19/ Accepted:15-Sep-19/Published Online:10-Oct-19

ABSTRACT
Severe ARDS in pediatrics is a life-threatening illness associated with significant morbidity and mortality, which often needs use of rescue ventilatory and non-ventilatory strategies. Despite non-encouraging results of HFOV in adults, its use still continues in pediatric population. We present three cases of primary severe ARDS, where oxygenation was refractory to conventional ventilation, prone positioning with conventional ventilation and to HFOV ventilation in supine position. In all these three cases oxygenation markedly improved with HFOV ventilation with prone positioning. Out of the three, two patients survived and one succumbed during the course of illness. We would like to hypothesize that prone positioning is feasible on HFOV and can be used as a rescue strategy for improving oxygenation and outcome when other measures fail.

Key words : HFOV, Prone positioning, severe ARDS

Case series

Patient 1 – ARDS: Probably bacterial pneumonia
6-month-old female infant was admitted to the PICU for worsening breathing difficulty and sensorium. She had history of fever, cough & cold 5 days before, for which she was treated outside. But as she developed poor sensorium and breathing difficulty she was admitted in a hospital and shifted to our centre. At admission, child was in respiratory distress (RR 80/min), desaturating (SpO2 75% at room air) and had features of shock (poor pulses, delayed CRT, low BP). She had bilateral crepitations with decreased air entry on right side. She was started on HFNC (flow- 2 L/Kg, Fio2-0.6), inotropes and IVF. But as her distress worsened, she was intubated within an hour of admission and started on conventional ventilation (SIMV Vt-6ml/kg, FiO2-0.6, PEEP-8, f-30.) CXR done was suggestive of right upper lobe collapse with diffuse bilateral infiltrates. Septic screen was positive and she was started on empirical broad spectrum antibiotics. Even after titrating PEEP, there was no improvement in clinical condition & oxygenation and S:F ratio was 116. Therefore, HFOV was initiated (MAP-23, A-35, Frequency 10, FiO2-1) at 5 hours of admission. To improve oxygenation and ventilation child was given prone position with HFOV by 12 hours of admission. Her condition stabilised by 6 hours and subsequently her ventilatory requirement decreased. She was given 3 cycles of prone ventilation (18 hours prone, 6 hours supine).
On day 4, she was shifted to conventional ventilation as HFOV requirement decreased (MAP-12, FiO2-0.4 on HFOV). After 3 hours on CMV child had dropping saturation. CXR was suggestive of right upper zone collapse. Suspecting mucus plug flexible bronchoscopy was planned but during the procedure child had severe desaturation and cardiac arrest from which she could not be revived.

**Patient 2 – H1N1 ARDS**

4-year-old male child was referred from outside hospital for worsening respiratory distress (was on HFNC, FiO2-0.45, flow-8 L/min, syrup oseltamivir, Inj Piperacillin-tazobactam, Inj. Vancomycin) with H1N1 infection. On admission, his saturation was 75% on room air with significant work of breathing with bilateral crepitations. Initially he was continued on HFNC (flow increased to 25L/min, Fio2-0.6) with oseltamivir and intravenous antibiotic. Chest X-ray was suggestive of diffuse bilateral infiltrates. But by 4 hours, as there was worsening of distress, P/F ratio of 80 and respiratory acidosis on blood gas, he was intubated and taken on mechanical ventilation (mode SIMV- Fio2-0.7, f-28, Vt-6.5ml/kg). His saturation did not stabilize even with high peak pressures (50 cm H2O) and his Oxygenation index was 44. So after 8 hours he was shifted on HFOV (MAP-30, Frequency-8, Amplitude-40, FiO2-1) with iNO (40ppm) with neuromuscular blocker infusion. He was later started on alternating prone (18hrs) and supine (6hrs) positions, with close monitoring of blood gas and methaemoglobin. He also received Methylprednisolone for ARDS. After 5 days of HFOV, iNO and prone positioning (alternating prone and supine - total 5 cycles given) he started maintaining saturation with less support (Fio2-0.4) & his P/F ratio improved. He was then shifted to conventional ventilation. He was weaned gradually and after another 48 hours of ventilation, he was extubated to HFNC, which was tapered and stopped in next 48 hours. He was discharged on 16th day from hospital and has been doing well on follow up.

**Patient 3 – MYCOPLASMA ARDS**

3-year-old female child was admitted to outside hospital with complaints of cough for 15 days, fever with chills for 7 days and breathing difficulty from 2 days. She was on broad spectrum antibiotics and supportive care. In view of worsening of respiratory distress, she was referred to our centre. At admission, she had significant respiratory distress with bilateral crepitations and SpO2 85% at room air. She was started on HFNC with flow of 22L/min and FiO2 of 0.45. Even after 5 hours there was worsening of distress, increasing respiratory acidosis and P: F < 80. Hence, she was intubated and started with SIMV mode (FiO2-1, PEEP-7, f-28, Vt-7 ml/kg)). Her Oxygenation index (OI) was 37, hence within 2 hours she was shifted to HFOV (MAP-30, Frequency-8, Amplitude-40, FiO2-1) and later to prone ventilation. Her ET secretion PCR sent for respiratory organisms came positive for mycoplasma pneumoniae for which she was started on Inj. doxycycline. On HFOV she was managed with alternating prone (18 hrs) and supine (6 hrs) positions with close monitoring of blood gases. 2 such cycles of prone positioning were given. After 55 hours she started maintaining saturation without distress and P:F ratio improved to 175. She was shifted to conventional ventilation from which she was extubated to HFNC in another 24 hours. Gradually HFNC was weaned and stopped in 72 hours. During the course, she was found to have simple mild pneumothorax and subcutaneous emphysema which was managed conservatively. She was shifted to the ward on day 16 for management of necrotising pneumonia (persistent fever and CT-chest suggestive of B/L cavities) and was discharged after 25 days of total hospital stay. On follow up she is doing well.

**Discussion**

HFOV is still primarily used as a “rescue therapy” in children with Diffuse Alveolar Disease. HFOV is usually started when there is severe hypoxemia with plateau pressure of 30 cm H_2O or more despite use of permissive hypercapnia for at least two hours or an oxygenation index of >13 demonstrated by two arterial blood gas measurements over 6-hour period. However, at times, decision to start HFOV is earlier, based on clinical judgement.

In ARDS, lung injury is heterogeneous and varies with position, more significant in areas that depend on gravity, eg. dorsal lung in supine position. Prone position may improve gas exchange by redistributing ventilation to better perfused dorsal lung areas.
and mediating homogenisation of tidal volume distribution associated with changes in chest wall mechanics, alveolar recruitment, and redirection of comprehensive forces exerted by weight of heart on lungs, resulting in better removal of secretions.

RCT done by Fineman et al, showed that prone positioning can be safely performed in critically ill paediatric patients and that these patients can be safely managed while in the prone position for prolonged periods of time. Two recent large randomized controlled trials (RCTs) in adults demonstrated that HFOV was no better than a lung protective strategy delivered by conventional mechanical ventilation. Recently, studies have shown that there is improved survival in patients treated with early prone positioning. An RCT was done in 2005, in which ventilated patients (CMV/HFOV) with acute lung injury were directly enrolled for prone vs supine positioning. However, in our case series HFOV with prone positioning was used as rescue modality to improve oxygenation when conventional ventilation failed. All of our patients were less than 5 years of age and prone positioning was done within 24 hours of admission. OI and OSI in all three cases on conventional ventilator was very high.

All three cases were HFOV and prone positioning success in terms of improved oxygenation. However, one infant died during bronchoscopy procedure which was done for persistent right upper lobe collapse, although she was shifted to conventional ventilator by then. We used early (within 24 hr in all cases) and prolonged prone positioning (>16 hrs in all three cases).

In all three cases we also used other non-ventilatory strategies for refractory hypoxemia such as use of NMB (all three patients), use of iNO (in 1 case), systemic steroids (in 1 case). Lung recruitment was probably best achieved after combination of HFOV and prone positioning and we hypothesize that this form of treatment modality can be tried when all other modalities fail and especially when ECMO facility is unavailable. Results of upcoming PROspects trial should be able to throw more light on this comparatively less explored strategy.

Conclusion
Clinical implication of these case series would mean benefit of prone positioning with HFOV as good oxygenation strategy when conventional ventilatory and non-ventilatory strategies do not succeed.

Source of Funding: Nil
Conflict of Interest: Nil

References


