Effect of early nasal continuous positive airway pressure in preterm neonates with mild-to-moderate hyaline membrane disease in a rural area – An analytic prospective observational study

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ABSTRACT

Background: Respiratory distress syndrome (RDS) is the major cause of morbidity and mortality in preterm newborns. Continuous positive airway pressure (CPAP) acts by preventing atelectasis and improves functional residual capacity and arterial oxygenation. Aims: This study aims to evaluate the effectiveness of early nasal bubble CPAP in treating preterm neonates with mild-to-moderate RDS in the rural setting. Materials and Methods: It is a prospective analytic observational study done at a tertiary hospital in the rural area of southern India from December 2018 to December 2019. All babies between 28 and 34 weeks of gestation with mild and moderate RDS were included in the study. Babies with severe RDS requiring surfactant were excluded from the study. Results: Incidence of RDS among babies born between 28 and 34 weeks of gestation was 3.2%. Out of total 50 babies who were managed with early nasal CPAP, it proved effective in 43 babies (86%), while remaining 7 babies (14%) had to be intubated and required ventilation. Babies were studied based on radiological appearance and we found a success rate of 93.1% in moderate grade hyaline membrane disease (HMD) (p<0.005). Conclusion: Bubble CPAP is effective in treating mild and moderate cases of RDS at peripheral center and help decrease the burden at tertiary care center.

Key words: Continuous positive airway pressure, Preterm, Respiratory distress syndrome

Neonatal respiratory distress syndrome (RDS), formerly known as hyaline membrane disease (HMD), is a common complication of prematurity [1]. In babies born at 28–32 weeks, RDS occurs in up to 50% of live births [2]. In the 1960s, mechanical intermittent positive pressure ventilation was widely accepted as the standard treatment of RDS in the newborns [3]. Later in 1976, Wung et al. stated introduction of continuous distending pressure (CDP) as a major breakthrough and an important modality of treatment in RDS [4]. The effect of grunting respiration on arterial oxygenation also suggested that continuous positive airway pressure (CPAP) might be useful. Therefore, CPAP was considered as a missing link between the oxygen and ventilator therapy.

In high-income countries, CPAP has reduced the requirement and duration of mechanical ventilation in neonates, along with a gain in popularity as an initial method of respiratory support for premature infants [5-7]. However, mechanical ventilation is complex, requires more expertise, and is an expensive modality. Whereas, bubble CPAP is a simpler intervention for respiratory distress, economical, and more accessible in low- and middle-income countries [1,8]. With the advent of antenatal glucocorticoids inducing surfactant maturation, a decrease in the need of exogenous surfactant therapy is noted [9]. With the above background, there is a global trend favoring noninvasive ventilation and highlighting early CPAP as a primary mode of treatment even in low-income countries. There is a paucity of literature with only few studies addressing the research question [1,8,10,11]. Moreover, the available literature comprises studies done before 2015. The present study was a hospital-based study in rural India and aimed at managing babies with hyaline membrane disease with a non-invasive approach in the form of timely nasal CPAP.

MATERIALS AND METHODS

The study was conducted at a tertiary center in South India. It was a prospective analytic observational study with an aim to evaluate the effectiveness of timely nasal bubble CPAP in rural setting. The
study duration was 13 months, from December 2018 to December 2019. The study population included neonates between 28 and 34 weeks gestational age presenting with mild-to-moderate HMD. Written and informed consent was obtained from parents/guardians. We excluded neonates with congenital malformations, babies born to mothers who had received general anesthesia, phenobarbitone, pethidine, and other drugs likely to depress the baby and severe RDS cases with Grades 3 and 4 radiographic changes.

Babies were classified as mild, moderate, and severe grade HMD based on radiological findings of the X-ray [12]. All babies with HMD were evaluated clinically and monitored using Silverman Anderson (SA) scoring, and pulse oximetry. Babies with SA score of >4 or requiring fraction of inspired oxygen (FiO₂) 0.6 to maintain partial pressure of oxygen in arterial blood (PaO₂) above 60 mmHg were treated with nasal CPAP. Nose mask type of nasal interfaces was used to deliver bubble CPAP. Effectiveness of the intervention was assessed using SA score and pulse oximetry monitoring. Arterial blood gas (ABG) was performed when required, based on the unit protocol. CPAP therapy was considered successful when the baby could maintain saturation >85% without any signs of respiratory distress and with a PaO₂ >60 mmHg, partial pressure of carbon dioxide in arterial blood (PaCO₂) <45 mmHg, and pH between 7.35 and 7.45 with FiO₂ <0.6. Failure of CPAP was considered when there was worsening distress (SA score> 6), or recurrent apnea or increased FiO₂ requirement (>0.6) with a PaO₂ <60 mmHg or PCO₂ >60 mmHg. When CPAP therapy failed, babies were ventilated and referred to a tertiary care center after surfactant administration.

Data were collected in a pro forma designed for the study and analyzed using SAS 9.4 software. “p”<0.05 was accepted as indicating statistical significance.

RESULTS

Flow diagram of the study population is depicted in Fig. 1. Incidence of preterm delivery and RDS was 12.42% and 3.2%, respectively. There were 50 neonates between 28 and 34 weeks of gestation with mild-to-moderate HMD satisfying the inclusion criteria during the study period. Out of 50 babies who were enrolled, CPAP proved to be effective in 43 babies (86%), while the remaining 7 babies (14%) required intubation and upgrading of respiratory support.

Baseline characteristics of the study population with outcome-based analysis are depicted in Table 1. As the gestational age of the baby advances, the outcome was better with 100% success rate observed in babies >33 weeks of gestation. There was statistically significant difference between success and failure groups with respect to gestational age (p<0.001).

Table 2 summarizes effect of nasal CPAP on SA score before and 6 h after initiation of therapy. It is found that success rate was 96.42% in babies of mothers who had received antenatal steroids, whereas only 72.72% of the babies improved whose mothers did not receive antenatal steroids (p<0.05). Hence, antenatal steroids

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>CPAP success (n=43)</th>
<th>CPAP failure (n=7)</th>
<th>p-value</th>
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<tr>
<td>Gender</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Male</td>
<td>27</td>
<td>3</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Female</td>
<td>16</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Gestational age (weeks)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28–30</td>
<td>4</td>
<td>6</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>31–32</td>
<td>29</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>33–34</td>
<td>10</td>
<td>0</td>
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<tr>
<td>Birth weight (g)</td>
<td></td>
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<td>&lt;1000 g</td>
<td>2</td>
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<td>&gt;0.05</td>
</tr>
<tr>
<td>1000–1500 g</td>
<td>30</td>
<td>6</td>
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<tr>
<td>1501–2000 g</td>
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<tr>
<td>Antenatal steroid status</td>
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<td>&lt;0.05</td>
</tr>
<tr>
<td>Not received</td>
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<td>6</td>
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</tbody>
</table>
administration in mother had definitive role in better outcome of HMD.

DISCUSSION

The incidence of prematurity and HMD in our study was 12.42% and 3.2%, respectively. The incidence of HMD in this study was 3.2%. Surfactant therapy is a cornerstone in the management of severe RDS. As surfactant storage, administration, technique of asepsis, and shortage of skilled personnel are the challenges faced in rural India, we excluded severe RDS cases which required surfactant immediately after birth and focused on the mild-to-moderate cases. This was also supported by literature from an Indian study by Koti et al. [13], where infants with Grades 3 and 4 chest X-ray findings, and those with higher FiO2 requirement had high risk of CPAP failure needing mechanical ventilation.

Out of 50 babies who were treated with early nasal CPAP, 64% were male and 36% were female. The evidence of a poorer prognosis in boys has been widely reported in the literature [14]; however, no such finding was observed in our study. Urs et al. [15] also found no statistically significant difference in outcome between males and females.

We studied the relationship between gestational age of the baby at birth and the outcome. Analysis of our study results showed that outcome was better with increase in gestational age (p<0.05). Urs et al. [15] found better outcome in babies with gestational age of 32–34 weeks (p<0.001). Ammari et al. [16] demonstrated that CPAP was successful in 87.4% of infants who were ≥26 weeks of gestation.

We looked into the effect of birth weight of the babies and overall outcomes. CPAP intervention was successful in all the babies >1500 g. In babies <1000 g, 66.6% had successful results. A study by Narendran et al. [5] has also shown better outcomes in extremely low birth weight babies. Another study by Joris et al. [17] has shown significant reduction in intubation rate in babies <1500 g (from 72.1% to 30.8%; p<0.01). In our study, we did not find any significant difference in the outcome of babies based on birth weight statistically. Urs et al. [15] showed better outcomes with statistical significance in babies with birth weight 1000–1500 g (p<0.001).

In our study, effectiveness of early nasal CPAP was judged based on SA scoring. We found statistically significant improvement (p<0.005) in SA score after application of nasal CPAP. SA scoring also helped us to predict which babies would require upgradeation of respiratory support. Similarly, Urs et al. showed significant improvement in Downes score after application of bubble CPAP.

Establishment of early nasal CPAP in rural health centers is useful in treating mild and moderate cases of HMD. This is crucial as it decreases the burden in tertiary care hospitals promising effective outcomes in the babies. Use of early nasal CPAP is simple, non-invasive, and has low capital outlay.

REFERENCES


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