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Comparison Of Nasal Intermittent Positive Pressure Ventilation and Nasal Continuous Positive Airway Pressure in Preterm Infants with Respiratory Distress Syndrome: A Randomized Controlled Study

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ABSTRACT

Background: Respiratory distress syndrome (RDS) is a major cause of morbidity and mortality among preterm neonates due to surfactant deficiency and structural immaturity of the lungs. Non-invasive respiratory support strategies have become the cornerstone of initial management in these infants. Nasal continuous positive airway pressure (nCPAP) has traditionally been used as the first-line therapy; however, treatment failure rates remain substantial. Nasal intermittent positive pressure ventilation (nIPPV) has emerged as an alternative non-invasive ventilation strategy that augments spontaneous breathing with intermittent positive pressure breaths. This may improve ventilation, reduce work of breathing, and decrease the need for invasive mechanical ventilation.

Methods: A hospital-based randomized controlled trial was conducted in the Department of Pediatrics, from February 2020 to December 2021. A total of 180 preterm neonates (<34 weeks gestation) diagnosed with respiratory distress syndrome were enrolled and randomly assigned to two groups: nIPPV (n=90) and nCPAP (n=90). Baseline neonatal characteristics were recorded. Primary outcomes evaluated were duration of respiratory support, duration of oxygen therapy, and length of hospital stay. Secondary outcome assessed was requirement of re-intubation. Statistical analysis was performed using SPSS version 21, with $p<0.05$ considered statistically significant.

Results: Baseline characteristics such as age at admission, gender distribution, and birth weight were comparable between the two groups. Mean duration of respiratory support was significantly shorter in the nIPPV group compared with the nCPAP group (6.2±1.77 vs 8.3±2.9 days). Duration of oxygen therapy was also lower in the nIPPV group (9.9±2.7 vs 12.8±2.7 days). Mean hospital stay was significantly shorter among neonates receiving nIPPV (15.1±2.9 days) compared with those receiving nCPAP (21.3±5.4 days). Re-intubation was required in 13.3% of infants in the nIPPV group compared with 47.8% in the nCPAP group.

Conclusion: Nasal intermittent positive pressure ventilation is more effective than nasal continuous positive airway pressure in reducing duration of respiratory support, oxygen requirement, and hospital stay in preterm infants with respiratory distress syndrome. It also significantly decreases the need for re-intubation.

Keywords*: Respiratory distress syndrome; nIPPV; nCPAP; preterm neonates; non-invasive ventilation.*

INTRODUCTION

Respiratory distress syndrome (RDS), also known as hyaline membrane disease, is one of the most common causes of respiratory failure in premature neonates. The condition arises primarily due to surfactant deficiency and structural

immaturity of the lungs, leading to decreased pulmonary compliance, alveolar collapse, and impaired gas exchange. The incidence of RDS is inversely related to gestational age, affecting approximately 60–80% of infants born before 28 weeks and 15–30% of infants born between 32 and 36 weeks of gestation.[1-3]

Advances in neonatal intensive care have significantly improved survival rates among preterm infants. Early use of non-invasive respiratory support has become a key component in the management of neonatal RDS, as it helps maintain functional residual capacity, improves oxygenation, and reduces the need for invasive mechanical ventilation. Nasal continuous positive airway pressure (nCPAP) is widely recommended as the initial mode of respiratory support in preterm infants with RDS.[4,5] Early use of CPAP has been shown to reduce the need for endotracheal intubation and mechanical ventilation.

Despite its benefits, nCPAP has certain limitations. Failure rates ranging from 15% to 50% have been reported, necessitating escalation to invasive ventilation in a considerable proportion of preterm infants.[6] Treatment failure may result from inadequate ventilation, persistent apnea, or progressive respiratory fatigue.

Nasal intermittent positive pressure ventilation (nIPPV) is an advanced form of non-invasive ventilation that delivers intermittent positive pressure breaths in addition to continuous positive airway pressure. This approach enhances tidal volume and minute ventilation, improves carbon dioxide clearance, and reduces work of breathing.[7] Several clinical trials have demonstrated that nIPPV may reduce extubation failure, decrease the need for mechanical ventilation, and improve respiratory outcomes in premature neonates.

Although both nCPAP and nIPPV are widely used in neonatal intensive care units, the relative efficacy of these two modalities in the management of preterm infants with RDS remains an area of ongoing investigation. Therefore, the present randomized controlled study was conducted to compare the efficacy of nasal intermittent positive pressure ventilation and nasal continuous positive airway pressure in preterm infants with respiratory distress syndrome.

OBJECTIVE

To compare the efficacy of nasal intermittent positive pressure ventilation (nIPPV) and nasal continuous positive airway pressure (nCPAP) in preterm infants with respiratory distress syndrome.

MATERIALS AND METHODS

Study Design: Hospital-based randomized controlled trial.

Study Setting: Department of Paediatrics, S.M.S. Medical College and associated group of hospitals, Jaipur, Rajasthan.

Study Duration: February 2020 to December 2021.

Study Population: Preterm neonates admitted to the neonatal intensive care unit with clinical and radiological features suggestive of respiratory distress syndrome.

Sample Size: The sample size was calculated at a 95% confidence level assuming a standard deviation of 21 days for hospital stay among premature neonates with RDS receiving non-invasive ventilation. To detect a minimum difference of 9 days in hospital stay with 80% study power, the minimum required sample size was 86 neonates per group. To account for possible attrition, a total of 180 neonates were enrolled in the study, with 90 neonates allocated to each group.

Inclusion Criteria

- Preterm neonates <34 weeks gestation
- Clinical signs of respiratory distress including tachypnea, nasal flaring, chest retractions, grunting, or cyanosis
- Radiological features suggestive of RDS such as reticulogranular pattern, air bronchograms, or ground-glass appearance
- Neonates receiving surfactant therapy
- Silverman Anderson respiratory score between 5 and 7 indicating moderate respiratory distress

Exclusion Criteria

- Birth asphyxia
- Major congenital anomalies
- Cardiovascular instability
- Respiratory distress due to causes other than RDS
- Multiple organ failure

- Infants intubated at admission
- Lack of parental consent

Randomization: Eligible neonates were randomly allocated to either the nIPPV group or the nCPAP group using the sealed envelope method. Randomization ensured that each participant had an equal chance of being assigned to either treatment group.

Study Groups
Preterm neonates with RDS receiving nasal intermittent positive pressure ventilation (nIPPV) were kept in **Group A** (n=90); and preterm neonates with RDS receiving nasal continuous positive airway pressure (nCPAP) were kept in **Group B** (n=90).

Outcome Measures
Primary outcomes were duration of respiratory support; duration of oxygen supplementation; and length of hospital stay. Secondary outcome was requirement of re-intubation.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 21. Continuous variables were expressed as mean ± standard deviation and compared using independent t-tests. Categorical variables were analyzed using chi-square tests. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Baseline Characteristics
Mean age at admission was **5.64±1.89 hours** in the nIPPV group and **5.41±2.06 hours** in the nCPAP group, with no statistically significant difference (Table 1). Gender distribution between groups was comparable (Table 2). Mean birth weight was **1340±200 g** in the nIPPV group and **1371±174 g** in the nCPAP group (Table 3).

Table 1: Distribution of infants according to age at admission

Age (hours)	nIPPV (n=90)	nCPAP (n=90)
<3 hours	1 (1.1%)	0 (0%)
3–6 hours	63 (70%)	68 (75.6%)
>6 hours	26 (28.9%)	22 (24.4%)

Table 2: Distribution of infants according to gender

Gender	nIPPV	nCPAP
Female	53 (58.9%)	40 (44.4%)
Male	37 (41.1%)	50 (55.6%)

Table 3: Distribution of infants according to birth weight

Birth weight (g)	nIPPV	nCPAP
1000–1250	22 (24.4%)	23 (25.6%)
1251–1500	46 (53.3%)	39 (43.3%)
>1500	20 (22.2%)	28 (31.1%)

Primary Outcomes
Duration of respiratory support: Mean duration of respiratory support was observed to be 6.2 ± 1.77 days with nIPPV; and 8.3 ± 2.9 days with nCPAP. This difference was statistically significant.
Duration of oxygen therapy: Mean duration of oxygen supplementation was observed to be 9.9 ± 2.7 days with nIPPV; and 12.8 ± 2.7 days with nCPAP. This difference was statistically significant.
Duration of hospital stay: Mean hospital stay was observed to be 15.1 ± 2.9 days with nIPPV; and 21.3 ± 5.4 days with nCPAP. Neonates treated with nIPPV had a significantly shorter hospital stay.

Secondary Outcome
Requirement of re-intubation: Re-intubation was required in 12 infants (13.3%) in nIPPV group; and 43 infants (47.8%) in nCPAP group. The difference was statistically significant**.**

DISCUSSION

In present randomized controlled trial, the efficacy of nasal intermittent positive pressure ventilation was compared with nasal continuous positive airway pressure in preterm infants with respiratory distress syndrome. Birth weight is a critical

determinant of neonatal survival, particularly in multiple gestations, where intrauterine growth restriction and prematurity are common.[8] Baseline neonatal characteristics including age at admission, gender distribution, and birth weight were comparable between the two groups, indicating successful randomization and minimizing selection bias.

One of the key findings of this study was the significantly shorter duration of respiratory support in neonates treated with nIPPV. The mean duration of respiratory support in the nIPPV group was 6.2 days compared with 8.3 days in the nCPAP group. Similar findings were reported by Armanian et al., who observed significantly shorter duration of respiratory support among neonates treated with nIPPV compared with those receiving nCPAP.[9]

The duration of oxygen therapy was also significantly lower in the nIPPV group. Reduced oxygen dependency suggests improved alveolar ventilation and lung recruitment. Previous studies have demonstrated that intermittent positive pressure breaths delivered during nIPPV improve tidal volume and ventilation efficiency.[10]

Another important observation in the present study was the significantly shorter hospital stay among neonates treated with nIPPV. Shorter hospital stay is clinically important as it reflects faster recovery and reduced healthcare burden. Similar findings were reported by Esmaeilnia et al., who found that nIPPV significantly reduced hospital stay in preterm infants with RDS.[11]

The requirement of re-intubation was markedly lower in the nIPPV group compared with the nCPAP group. This suggests that nIPPV provides more effective respiratory support and reduces treatment failure. Kugelman et al. also demonstrated that nIPPV significantly decreased the need for endotracheal ventilation in preterm infants with respiratory distress syndrome.[12]

Overall, the results of this study support the growing body of evidence suggesting that nIPPV may offer advantages over nCPAP in the management of neonatal RDS.

CONCLUSION

Nasal intermittent positive pressure ventilation is more effective than nasal continuous positive airway pressure in the management of respiratory distress syndrome in preterm infants. It significantly reduces the duration of respiratory support, oxygen requirement, length of hospital stay, and the need for re-intubation.

These findings suggest that nIPPV may be considered a superior non-invasive ventilation strategy for preterm infants with respiratory distress syndrome.

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