Original Article

STUDY ON BUBBLE CPAP VERSUS VENTILATOR CPAP IN PRETERM NEONATES WITH EARLY ONSET RESPIRATORY DISTRESS

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Abstract

Background: The most common cause of respiratory failure in premature infants is respiratory distress syndrome. Historically, respiratory distress syndrome has been treated by intratracheal surfactant injection followed by mechanical ventilation. In view of the risk of pulmonary injury associated with mechanical ventilation and subsequent chronic pulmonary lung disease, less invasive treatment modalities have been suggested to reduce pulmonary complications. Bubble CPAP (BCPAP) has been reported as a safe and effective method for delivering CPAP in peri-extubation phase in ventilated preterm infants

Aim and Objectives: The objective of our study is to compare the efficacy and safety of BCPAP with VCPAP.

Materials and Methods: After randomization, the neonates were allocated to receive either BCPAP or VCPAP at a pressure of 6 cm of water and oxygen concentration of 40%. CPAP pressure and FiO2 was adjusted depending on clinical assessment of the neonate and maintenance of oxygen saturation between 88 and 93%. The CPAP pressures were changed by 1 cm of water, and FiO2 was changed by 5%, at every step. After 1 hr of CPAP support, if the need for CPAP pressure remained 6 cm of water and oxygen need persisted 40%, a chest X-ray was repeated. In presence of an FIO2 requirement >40% and Chest X-ray showing signs of RDS, the INSURE approach (Intubate, administer surfactant and extubate to the allocated mode of CPAP) was undertaken for surfactant replacement. The total time for this procedure was 10–15 min. Use of methylxanthines such as aminophylline was not a routine during study period but was considered in presence of an episode of apnea.

Discussion and Conclusion: The present study intended to evaluate the efficacy and safety of BCPAP versus VCPAP. We enrolled a total of 108 preterm babies delivered at our institute. Preterm neonates were randomly allocated into two groups, B group who were on BCPAP and V group for the neonates who were put on VCPAP. The gestational age, birth weight in grams in VCPAP were 30.61±2.8 weeks, 1524±12.4 grams and in BCPAP 31.21±2.4 weeks and 1526±19.6 grams respectively. In VCPAP 77.7% were on antenatal steroids and 79.62% in BCPAP group. 25.92% had clinical chorioamnionitis in VCPAP and 27.77% in BCPAP. Chest x- ray revealed RDS in 81.48% preterm neonates in VCPAP and 83.33% in BCPAP respectively.

We evaluated the outcome of both VCPAP and BCPAP, we found that 85% had success in VCPAP and 94.44% in BCPAP. 57.4% had morbidity in VCPAP and 70.37% in BCPAP. The mortality was 7.4% in both the groups. Out of the total 108 preterm neonates, 97 had success and failure was seen

in 11 neonates. SA score, a/A ratio, surfactant was 5, 0.34, 10 in success and 6, 0.26, 8 in failure respectively. In BCPAP group 51% had success and 7.4% failure. Types of morbidities were compared in both the groups, we found that dilation of nares, nasal septal injury, skin erosion, dislodgement, abdominal distension were seen in 13, 3, 1, 32, 2 preterm neonates in VCPAP group and 15, 11, 2, 29, 6 preterm neonates in BCPAP group respectively. None of the preterm neonates showed secondary pneumonia and air leak. Nasal septal injury was more common in BCPAP compared to VCPAP.
BCPAP is safe and effective method of treating early respiratory distress in preterm neonates. Definitive large trial is needed to confirm these findings.

Key-words: respiratory distress, preterm neonates, bubble continuous positive airway pressure and ventilator continuous positive airway pressure.

INTRODUCTION:

The most common cause of respiratory failure in premature infants is respiratory distress syndrome. Historically, respiratory distress syndrome has been treated by intratracheal surfactant injection followed by mechanical ventilation. In view of the risk of pulmonary injury associated with mechanical ventilation and subsequent chronic pulmonary lung disease, less invasive treatment modalities have been suggested to reduce pulmonary complications. Nasal continuous positive airway pressure (CPAP) is an established modality of respiratory support in preterm neonates with respiratory distress [1]. Various modes of nasal CPAP delivery have been tried in neonates. Bubble CPAP (BCPAP) has been reported as a safe and effective method for delivering CPAP in peri-extubation phase in ventilated preterm infants [2]. Given its low cost, BCPAP has a potentially significant role in the management of such neonates in resource poor nations [3, 4]. In a pilot trial, in neonates with moderate respiratory distress in first 6 h of life, have shown that BCPAP and VCPAP have comparable efficacy and safety [4-5]. This larger study was designed to compare the efficacy and safety of BCPAP with VCPAP in preterm neonates with moderate to severe respiratory distress.

AIM AND OBJECTIVES:

The objective of our study is to compare the efficacy and safety of BCPAP with VCPAP.

MATERIALS AND METHODS:

Source of data: The study was conducted at Paediatric NICU of our tertiary care hospital from January 2021 to December 2022.

Study design: A randomised control trail was conducted at our tertiary care hospital at PNICU Dept. of Paediatrics.

Inclusion criteria: In the present study, we included, Preterm neonates (Gestation <37 weeks) with respiratory distress within 6 h and Silverman–Anderson (SA) score >4 and oxygen requirement >30% within first 6 h of life were eligible for enrolment after obtaining informed parental consent.

Exclusion criteria: Presence of any one of the following: (i) Lack of parental consent, (ii) Significant congenital malformations, (iii) Postnatal age >6 h, (iv) Already intubated for resuscitation. Randomization, allocation concealment and blinding Neonates eligible for enrollment were randomly allocated to either BCPAP or VCPAP using computer generated random numbers contained in sealed coded envelopes with labels wrapped in opaque aluminium foil. Given the

nature of the interventions, masking the primary research team members was not possible. The statistician was however masked to the allocation status of neonates. Recording of basic demographic and clinical data of neonates with parental consent was done before opening of coded envelopes to optimize allocation concealment.

Radiological diagnosis: Chest X-ray was obtained in all neonates before randomization. The radiological diagnoses were categorized into two groups: Respiratory distress syndrome (RDS) and no RDS. Arterial blood gas**:** Within 30 min of randomization, an arterial blood gas sample was analysed to calculate the arterial to alveolar oxygenation (a/A) ratio.
Clinical protocol: After randomization, the neonates were allocated to receive either BCPAP or VCPAP at a pressure of 6 cm of water and oxygen concentration of 40%. CPAP pressure and FiO2 was adjusted depending on clinical assessment of the neonate and maintenance of oxygen saturation between 88 and 93%. The CPAP pressures were changed by 1 cm of water, and FiO2 was changed by 5%, at every step. After 1 hr of CPAP support, if the need for CPAP pressure remained 6 cm of water and oxygen need persisted 40%, a chest X-ray was repeated. In presence of an FIO2 requirement >40% and Chest X-ray showing signs of RDS, the INSURE approach (Intubate, administer surfactant and extubate to the allocated mode of CPAP) was undertaken for surfactant replacement. The total time for this procedure was 10–15 min. Use of methylxanthines such as aminophylline was not a routine during study period but was considered in presence of an episode of apnea.

Primary outcome: Proportion of neonates with success or failure of the allocated mode of CPAP delivery was the primary outcome. Success was defined as follows: (i) stoppage of CPAP following reduced CPAP pressure (<4 cm H2O) and oxygen (<30%) requirement, (ii) clinical improvement (SA score 3), (iii) no need of CPAP/ mechanical ventilation for next 72 h. Failure was defined as presence of any of the following: (i) worsening SA scores, (ii) rise in oxygen requirement >60% and CPAP pressure >8 cm H2O, (iii) more than two episodes of apnea requiring positive pressure ventilation, (iv) shock. These neonates were intubated and mechanically ventilated.

Secondary outcomes: These included duration of CPAP support and complications such as pneumothorax and injury to nasal septum (erythema, abrasion or necrosis). Duration of CPAP was measured in hours, from time of its initiation to successful removal.

Equipment: Fischer Paykel Bubble CPAP generator with Blender & Columbia Bubble CPAP setup was used for delivering BCPAP. For VCPAP, Argyle binasal prongs were used to connect to Bear Cub 750 PSV ventilator. For both systems, appropriate sized nasal prongs were used to avoid leak. Decisions regarding the management of enrolled neonates were at discretion of the attending neonatologist. Nursing and resident medical staff underwent an in-service training in handling BCPAP before the pilot trial was initiated. Training of newly recruited staff continued throughout the trial period.

Statistical analysis: For categorical variables, 2 tailed test was used if cell frequency was greater than five, else Fisher's exact test was used. For continuous variables, Mann–Whitney
U test was applied; p-values <0.05 were considered statistically significant.

RESULTS:

In the present study, 108 neonates who were admitted to Neonatal Intensive Care Units (NICU) at our teritiary care hospital from January 2021 to December 20202 were included. The neonates were randomly allocated into two groups, B group with 54 neonates and V group with 54 neonates under trail. B group were put on BCPAP and V group were put on VCPAP.

Table 1: Shows the baseline characteristics at the time of initiation of CPAP		
Characteristics	**Ventilator CPAP (no=54)**	**Bubble CPAP (no=54)**
GA (weeks)	30.61±2.8	31.21±2.4
Birth weight in grams	1524±12.4	1526±19.6
Ante natal steroids	42 (77.77%)	43 (79.62%)
Clinical choriamnionitis	14 (25.92%)	15 (27.77%)
SA score	6	6
Chest x-ray		
RDS	44 (81.48%)	45 (83.33%)
No RDS	10 (18.51%)	9 (16.66%)

Table 2: Outcome of CPAP		
Characteristics	**Ventilator CPAP (no=54)**	**Bubble CPAP (no=54)**
Success	46 (85.18%)	51 (94.44%)
Morbidity	31 (57.40%)	33 (61.11%)
Mortality	4 (7.4%)	4 (7.4%)

Table 3: Shows the Characteristics of outcome of CPAP		
Characteristics	**Success (no=97)**	**Failure (no=11)**
SA score	5	6
a/A ratio	0.34	0.26
Surfactant	10	8
BCPAP	51 (52.57%)	4 (7.4%)

Table 4: Shows types of morbidities associated with CPAP		
Morbidity	**VCPAP**	**BCPAP**
Dilation of nares	13 (24.07%)	15 (27.77%)
Nasal septal injury	3 (5.55%)	11 (20.37%)
Skin erosion	1 (1.85%)	2 (3.7%)
Dislodgement	32 (59.25%)	29 (53.7%)
Abdominal distension	2 (3.7%)	6 (11.11%)
Secondary pneumonia	0	0
Air leak	0	0

DISCUSSION:

The present study intended to evaluate the efficacy and safety of BCPAP versus VCPAP. We enrolled a total of 108 preterm babies delivered at our institute. Preterm neonates were randomly allocated into two groups, B group who were on BCPAP and V group for the neonates who were put on VCPAP. The gestational age, birth weight in grams in VCPAP were 30.61±2.8 weeks, 1524±12.4 grams and in BCPAP 31.21±2.4 weeks and 1526±19.6 grams respectively. In VCPAP 77.7% were on antenatal steroids and 79.62% in BCPAP group. 25.92% had clinical chorioamnionitis in VCPAP and 27.77% in BCPAP. Chest x- ray revealed RDS in 81.48% preterm neonates in VCPAP and 83.33% in BCPAP respectively.

We evaluated the outcome of both VCPAP and BCPAP, we found that 85% had success in VCPAP and 94.44% in BCPAP. 57.4% had morbidity in VCPAP and 70.37% in BCPAP. The mortality was 7.4% in both the groups. Out of the total 108 preterm neonates, 97 had success and failure was seen in 11 neonates. SA score, a/A ratio, surfactant was 5, 0.34, 10 in success and 6, 0.26, 8 in failure respectively. In BCPAP group 51% had success and 7.4% failure. Types of morbidities were compared in both the groups, we found that dilation of nares, nasal septal injury, skin erosion,

dislodgement, abdominal distension were seen in 13, 3, 1, 32, 2 preterm neonates in VCPAP group and 15, 11, 2, 29, 6 preterm neonates in BCPAP group respectively. None of the preterm neonates showed secondary pneumonia and air leak. Nasal septal injury was more common in BCPAP compared to VCPAP.

The results of our study indicate that BCPAP was more successful than VCPAP in managing preterm neonates with early onset moderate to severe respiratory distress in our set up. Almost 4 decades ago, Gregory et al. [7] introduced CPAP in the management of respiratory distress of preterm neonates. The interest in CPAP was enhanced following reports highlighting lower incidence of chronic lung disease associated with its use [8–10]. The role of nasal CPAP in management of preterm neonates with respiratory distress is now well established. Short binasal prongs are the contact device of choice, but the need to determine optimal pressure source for delivery of nasal CPAP is reflected even in recent literature [11]. In a trial of 18 preterm neonates, BCPAP was associated with increased work of breathing compared with variable flow nasal CPAP [12]. Based on these results, it was postulated that BCPAP will have greater failure rates. Lee et al. [2] however suggested that compared with VCPAP, ventilation was more effective with BCPAP. In a cross-over trial, Morley et al. [13] reported no difference in oxygenation and arterial CO2 between BCPAP and VCPAP. These two trials recruited stable preterm neonates with resolving respiratory illness. Observational studies support the use of BCPAP as initial respiratory support [14–16]. However, literature comparing two common modes of CPAP delivery, BCPAP and VCPAP is limited. Two recent observational studies in our country have reported BCPAP success rates of 75% [14] and 80% [15]. Ammari et al. [16] have reported a success rate of 76% with BCPAP in their retrospective study. In a recent randomized controlled trial of 140 neonates during post-extubation period, BCPAP was as effective as infant flow driver [17]. In intubated preterm lambs, BCPAP was found to have physiological and biological advantages compared with VCPAP [18]. It was owing to reduced atelectasis with BCPAP secondary to improved peripheral airway patency. The increased amplitude of noisy oscillations transmitted to atelectatic lung with low compliance promotes reopening of airspaces [19]. At low lung volume, BCPAP improves airspace stability [20]. The variable stretch provided to airspaces during BCPAP is proposed to increase surfactant secretion [21]. This may explain significantly less need for surfactant in BCPAP group in present trial. When tried in intubated rabbits, BCPAP was superior to VCPAP in terms of its effect on arterial blood gases and vital signs [22]. These observations point to a promising role of BCPAP in the initial management of respiratory distress. Both BCPAP and VCPAP are comparable in terms of duration of support, associated morbidity and mortality.

In our trial, CPAP failure was associated with significantly higher SA score, lower a/A ratio and need for surfactant, indicating severity of the underlying disease. Urs et al. [15] have shown that BCPAP is more successful in milder RDS.

CONCLUSION:

BCPAP is safe and effective method of treating early respiratory distress in preterm neonates. Definitive large trial is needed to confirm these findings.

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