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Original Article

Use of Bubble Continuous Positive Airway Pressure in A Level II Neonatal Intensive Care Unit: A Descriptive Study

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Abstract

Background: Respiratory distress (RD) is an important cause of admission to the neonatal intensive care unit, which frequently requires respiratory support. Invasive mechanical ventilation is accompanied by many short-term complications and the long-term risk of chronic lung injury. Continuous positive airway pressure (CPAP), being noninvasive, is an effective mean of providing respiratory support and thereby reduces the mortality and morbidity in neonates.

Objective: To assess the efficacy of bubble CPAP (BCPAP) on immediate outcome of preterm and term neonates with mild to moderate RD in a Level II neonatal intensive care unit (NICU) in a tertiary care Government Hospital, Hyderabad, India.

Materials and Methods: Retrospective study was conducted at Level II NICU, Department of Neonatology, Niloufer Hospital from January to June 2016. All admitted neonates of gestational age >28 weeks with mild to moderate RD requiring BCPAP were included in the study.

Results: The total number of babies presenting with RD during the study period was 393. A total of 115 patients were put on BCPAP. The mean gestational age of the study population was 32.37 ± 3.42 weeks. The mean birth weight was 1.65 ± 0.610 kg. 71 were males (61.7%) and 44 were females (38.2%). Inborn babies were 25 (21.7%) and outborn babies were 90 (78.2%). The most common reason for starting CPAP was RD syndrome (76.5%), followed by pneumonia (12.1%). Out of 115 neonates placed on BCPAP, 63 (54.7%) were managed on BCPAP alone and were weaned successfully while 52 babies (45.3%) required mechanical ventilation and were considered in failure group. The success rate was better seen in inborn babies (60%; 15 out of 25) than outborn babies (53%; 48 out of 90).

Conclusion: BCPAP is useful in a tertiary care hospital where human resources are deficit. Availability of more CPAP facilities in peripheral hospitals can further improve the incidence of mortality and morbidity by decreasing the delayed referrals.

Key words: Bubble continuous positive airway pressure, Mortality, Preterm, Respiratory distress, Success, Term infants

INTRODUCTION

Respiratory illness is one of the most common causes of neonatal admissions and deaths in the developing world. An effective way to reduce the incidence of chronic lung injury is the use of continuous positive airway pressure (CPAP) and avoidance of mechanical ventilation.[1] Bubble CPAP (BCPAP) prevents alveolar collapse, ensures gas exchange throughout the respiratory cycle and allows lung inflation to be maintained. Preterm infant with mild or moderate hyaline membrane disease or with mild apnea of prematurity can be managed with CPAP.[2] However, CPAP has also been used to treat infants with other respiratory disorders including transient tachypnea of the newborn, meconium aspiration syndrome, primary pulmonary hypertension, pulmonary hemorrhage, and patent ductus arteriosus.[3] BCPAP is also a less expensive method of respiratory support, most suitable to neonatal units with limited resources in developing countries.[4] The present study was undertaken to assess the outcome

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of BCPAP in our hospital which is a tertiary care centre and to further assess factors leading to the success or failure of CPAP.

MATERIALS AND METHODS

A retrospective study was conducted on neonates of gestational age ≥28 weeks with mild to moderate respiratory distress (RD) admitted to a Level II neonatal intensive care unit (NICU), Department of Neonatology, Niloufer Hospital, Hyderabad. The study was conducted over a period of 6 months, i.e., from January to June 2016. Neonates with a gestational age ≥28 weeks with mild to moderate RD based on Silverman and Anderson score[5] and Downe's score[6] were included in the study. Exclusion criteria were neonates with RD syndrome (RDS) secondary to birth asphyxia, NEC, congenital anomalies, and neonates requiring intubation at birth and severe cardiovascular instability.

Patients' detailed history was inclusive of antenatal history, birth history and resuscitation details which were recorded from the case files. In our unit, study babies were put on BCPAP (Fischer and Paykel) as the initial form of respiratory support with short, bi nasal Hudson's cannulae. All babies were nursed under radiant warmers on servo-controlled skin mode. BCPAP was started with 5 cm H_2O and FiO_2 adjusted to maintain pulse oximeter saturation between 90 and 95%. Babies with a diagnosis of RDS were given surfactant if indicated and if available (Downe's score 4–6 or requirement of FiO_2 >0.4 CPAP). This was done by insure[7] (INtubate, SURfactant Extubate) technique and babies were then put back on CPAP. Monitoring was done clinically, with pulse oximeter, X-rays and ABGs for the requirement of a change in settings, complications, failure and outcome.

Weaning off BCPAP was done when the RD decreased to Downe's score <3 and ABGs were normal.

Failure[8] of BCPAP was defined as one or more of the following:

a. Remained hypoxemic, i.e., SpO2587% despite FiO_2 470% and PEEP 47 cm H_2O.
b. Had severe retractions on PEEP 47 cm H2O.
c. Had prolonged (420 s) or recurrent apneas (42 episodes within 24 h associated with bradycardia) requiring bag and mask ventilation.
d. Shock (clinical symptom of inadequate tissue perfusion with clinical signs such as cold extremities, mottling of the skin, tachycardia, and decreased urine output) requiring inotropic support (dopamine >20 mg/kg/min).

Analysis was performed with SPSS (version 20.0). Mean and standard deviation was computed for quantitative variables including birth weight and gestational age. Frequencies and percentages were reported for categorical variables. Student *t*-test was used to compare continuous variables and Chi-square test was applied to compare categorical variables. $P < 0.05$ was considered significant.

RESULTS

The total number of babies presenting with RD during the study period was 393, of which 115 patients were connected to BCPAP. The mean gestational age of the study population was 32.37 ± 3.42 weeks. The mean birth weight was 1.65 ± 0.610 kg. 71 were males (61.7%) and 44 were females (38.2%). Inborn babies were 25 (21.7%) and outborn babies were 90 (78.2%) as seen in Table 1.

Out of 115 babies put on BCPAP, 63(54.7%) were weaned successfully while others (52, 45.2%) required mechanical ventilation and were considered in failure group. The mean duration on CPAP was 2.45 ± 1.27 days.

These neonates with RD categorized according to the body weight to four categories that showed in Table 2. Most of the babies were in the weight category of 1000–1500 g.

Table 3 summarizes the most common reason for starting CPAP which was RDS (*n* = 88, 76.5%), followed by pneumonia (*n* = 14, 12.1%), meconium aspiration syndrome (MAS) (*n* = 10, 8.7%), and transient tachypnea of newborn (TTNB) (*n* = 3, 2.6%).

As depicted in Table 4 there is no statistical significant difference among the gender, weight and gestational age categories with regard to outcome of BCPAP. Table 4a summarizes that there is no significant difference with regard to gender and weight in babies receiving CPAP for RDS, gestational age category showed clinical significance.

Table 1: Baseline characteristics of babies on CPAP

Characteristic	*n* (%)
Gender	
Male	71 (61.7)
Female	44 (38.2)
Mean weight (kg)	1.650±0.610
Mean gestational age (weeks)	32.28±3.43
SGA	27 (23.07)
Gestation ≤30 weeks	39 (33.9)
Surfactant	17 (14.7)

SGA: Small for gestational age

The success rate was better seen in inborn babies (60%; 15 out of 25) than outborn babies (53%; 48 out of 90). The success rate of CPAP was more in babies with TTNB (n = 3,100%), followed by RDS (n = 51, 57.9%). The success rate was least in cases with MAS (n = 3, 30%).

Table 5 summarizes the distribution of CPAP outcome according to the weight category. The success rate of CPAP has increased as the weight progressed except in birth weight category >2500 g. The number of babies that were discharged was 75 (65.2%).

Table 2: Distribution of cases based on weight category

Wt category (g)	*n* (%)
≤1000	16 (13.9)
1000–1500	47 (40.8)
1501–2500	41 (35.6)
≥2500	11 (9.5)
Total	115 (100)

Table 3: Etiology of RD in babies receiving nasal CPAP

Cause of RD	Number of babies (%)
RDS	88 (76.5)
Pneumonia	14 (12.1)
MAS	10 (8.7)
TTNB	3 (2.6)
Total	115 (100)

MAS: Meconium aspiration syndrome, TTNB: Transient tachypnea of newborn, RDS: Respiratory distress syndrome, RD: Respiratory distress, CPAP: Continuous positive airway pressure

DISCUSSION

The study was undertaken to assess the outcome of CPAP and factors affecting the success of CPAP in neonates admitted with RD to our NICU. Total of 115 babies including both, preterm and term neonates who received CPAP during the study period were included. The mean birth weight was 1.65 ± 0.610 kg, which is similar to the study conducted by Umran *et al.*,[9] who also included neonates with all birth weights and different from Koti *et al.*,[8] de Klerk and de Klerk [10] who included only premature neonates. The mean gestational age in our study was 32.28 ± 3.43, which is similar to the study conducted by Umran *et al.*[9] 33.4 ± 2.75 (weeks), it's different with Koti *et al.*,[8] which was 30.98 ± 2 (weeks).

The mean duration on CPAP was 2.45 ± 1.27 days, similar reported by Umran *et al.*,[9] 2.85 (days) ± 2.11 different with Koti *et al.*, that was 0.97 days (0.08–6 days range).[8] This difference could be explained by the shortage of human resources and supportive care in our setup.

It was noticed in our study that the gender had no impact on the success of BCPAP which is similar to the found in studies by Koti *et al.*[8] and Urs *et al.*[11] It was noticed in our study that the gender, mean weight and mean gestational age had no impact on the success of CPAP which was similar to the study conducted by Sethi *et al.*,[12] the reason being both the settings are tertiary care centre. Gestational age ≤30 weeks had significant effect on the success of CPAP similar to the study by Ammari *et al.*[13]

Table 4: Baseline characteristics of infants and CPAP outcome

Variables	Total	Success	Failure	*P*
	n=115	*n*=63	*n*=52	
Gender				
Male	71	35	36	0.133
Female	44	28	16	
Mean weight (kg)	1.650±0.610	1.717±0.625	1.569±0.586	0.197
Mean gestational age (weeks)	32.28±3.43	32.68±3.29	31.79±3.56	0.165
Gestational age ≤30 weeks	39	17	22	0.0148

CPAP: Continuous positive airway pressure

Table 4a: Baseline characteristics of infants receiving CPAP for RDS and outcome

Variables	Total	Success	Failure	*P*
	n=88	*n*=51	*n*=37	
Gender				
Male	54	28	26	0.144
Female	34	23	11	
Mean weight (kg)	1.475±0.473	1.551±0.492	1.371±0.431	0.078
Mean gestational age (weeks)	31.28±2.94	31.86±2.92	30.48±2.82	0.030

RDS: Respiratory distress syndrome, CPAP: Continuous positive airway pressure

Table 5: Distribution of cases according to the body weight and effect of CPAP

Weight category (g)	*n* (%)	
	Success	Failure
≤1000	7 (43.7)	9 (56.2)
1000–1500	25 (53.1)	22 (46.8)
1501–2500	25 (60.9)	16 (39.0)
≥2500	6 (54.5)	5 (45.4)
Total	63 (54.7)	52 (45.2)

CPAP: Continuous positive airway pressure

It was found that 63 (54.7%) of cases were weaned successfully from CPAP and 52 (45.2%) of cases failed. Overall, mortality rate was 40 (34.7%).The success rate is almost similar to the study of Sethi *et al.*[12] which reported success rate of 60%. The effect of BCPAP was different from Koti *et al.*[8] who found 25% failure Sharba *et al.*[14] also reported a 66% success rate with CPAP, which is higher than our study. This could be explained by the differences in the study population, deficit of other supportive measures such as total parenteral nutrition, surfactant, and staff experience which can help to further decrease the mortality rate. The success rate in our study may also be lower due to delayed initiation of CPAP especially in outborn neonates.

The success rate of CPAP has increased as the birth weight of the neonates increased except for the weight category of ≥2500 g. This could be explained probably because most of the babies in this weight category had RD due to MAS and pneumonia. In our study, the failure rate in extremely low birth weight babies was 56.2%, which is lower than the failure rate observed by Umran *et al.*[9] In study by Ammari *et al.*[13] in babies' ≤1250 (g) the failure of CPAP was 24%.

The most common indication for CPAP in our study was RDS followed by sepsis, which is similar to the study conducted by Umran *et al.*[9] CPAP was successful in 57.9% of cases with RDS and failed in 42% of cases which is also similar to the study by Umran *et al.*[9] and Sethi *et al.*[12] Gender and birth weight had no significance on the outcome of CPAP. Higher gestational age had a significantly positive effect on the success of CPAP similar to the study by Hameed *et al.*[15]

The limitation of the present study is proper history could not be captured for the outborn babies as the referral letters were not complete. Further studies need to be done to assess the long-term outcome of the babies and follow-up for the intactness of the survival.

CONCLUSION

1. Using BCPAP in the management of RD was effective.
2. Increasing the availability of CPAP machines in the peripheral hospital can further improve the outcome.
3. Empowerment of human resources in tertiary care hospitals is the need of the hour.

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