

Bubble CPAP (Continuous Positive airway pressure) therapy as a primary mode of respiratory support in preterm newborns with mild to moderate respiratory distress syndrome

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Background: Respiratory distress syndrome (RDS) is an important cause of morbidity and mortality in preterm infants. Bubble CPAP when used appropriately, is more cost-effective, non-invasive, requires less training and has a lower risk of complications. However, not all preterm infants with RDS respond to CPAP. **Aims:** To study the immediate outcome of preterm infants with mild to moderate respiratory distress syndrome on Bubble CPAP. To study the safety and effectiveness of B-CPAP and to identify the risk factors associated with its failure. **Setting:** NICU, Department of pediatrics, Mamata general hospital and medical college, Khammam. Design- Prospective observational study **Material and Methods:** This duration bound study was conducted from February 2018 to February 2020. Based on the inclusion criteria 73 Preterm babies with mild to moderate respiratory distress syndrome requiring respiratory support were included in this study. Details of birth history, use of antenatal steroids, gestational age, type of delivery, birth weight, Downes score and chest X-ray were recorded. And the effectiveness and outcome of bubble CPAP were studied. **Results:** Out of the total of 73 cases, 53(72.60%) were treated successfully, while 20(27.40%) failed bubble CPAP. **Conclusion:** Bubble CPAP is the safe primary mode of respiratory support in Preterm newborns with mild to moderate RDS, more effective with early Initiation and in Preterm babies born to mothers with the use of antenatal steroids.

Keywords: Bubble CPAP, Preterm, Mild to moderate RDS

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Introduction

Respiratory distress syndrome (RDS) is an important cause of morbidity and mortality in preterm Newborn [1]. Current modalities of ventilatory assistance in the management of respiratory distress syndrome (RDS) in preterm infants range from continuous positive airway pressure (CPAP) to various modes of mechanical ventilation [2]. Continuous positive airway pressure (CPAP), when applied to premature infants with respiratory distress syndrome prevents the collapse of alveoli, splints the airway, reduces work of breathing and improves the pattern and regularity of respiration [3]. Mechanical ventilation is invasive and can injure the airway and lung parenchyma. An effective way to reduce the incidence of chronic lung injury is the use of continuous positive airway pressure [2,4]. Bubble CPAP (continuous positive airway pressure) is a less expensive method of respiratory support and most suitable to neonatal units with limited resources in developing countries [5]. B-CPAP when used appropriately, is more cost-effective, noninvasive, requires less training and has a lower risk of complications. However, not all preterm infants with RDS respond to CPAP [6]. The objective of the study was to evaluate the outcome in preterm newborns (28 to 37 weeks of gestational age) with mild to moderate respiratory distress syndrome on Bubble CPAP and to determine the risk factors associated with failure of B-CPAP.

Methodology

The study was conducted in the Neonatal Intensive Care Unit (NICU) of the department of pediatrics at Mamata General Hospital, Khammam. This prospective observational study was conducted for a period of 2 years from February 2018 to February 2020. In this duration bound study 73 preterm babies with mild to moderate respiratory distress syndrome requiring respiratory support were enrolled. Based on Downes score [7]. and radiological findings, the severity of RDS was graded as Mild, Moderate and Severe [8]. Preterm babies with mild to moderate RDS and whose parents had given consent were included in the study. Preterm babies with severe RDS requiring intubation and ventilator support were excluded. Babies with respiratory distress secondary to asphyxia, meconium aspiration, sepsis, NEC, congenital anomalies (congenital heart disease, cleft lip and palate, choanal atresia) were excluded.

Details of birth history, use of antenatal steroids, gestational age, type of delivery, birth weight, Downes score and chest X-ray were recorded.

The severity of RDS based on x-ray finding was graded as

- (I) mild - mild granularity of lungs,
- (ii) moderate - generalized granularity of lungs with air bronchogram with preserved cardiac borders, and
- (Iii) severe - whiteout lungs with loss of cardiac borders.

[8]. Downes score was used for grading the RDS and also for evaluating the clinical improvement in RDS. [7]. A sepsis screen was done to rule out sepsis in the studied babies.[9]. Blood culture was done when indicated to rule out sepsis. Preterm babies with mild to moderate RDS were put on B-CPAP as the initial form of respiratory support. All babies were nursed under radiant warmers on servo-controlled skin mode. The Fisher and Paykel Bubble CPAP with bi-nasal prongs was used, it involves a source of gas, an air oxygen blender, humidifier and respiratory circuit. The expiratory end of which inserted in a bottle of water. Fixation of the nasal interface was done as per guidelines provided in the All India Institute of Medical Sciences (AIIMS) booklet of neonatal protocols.[10] CPAP setting started with Positive End Expiratory Pressure (PEEP) 5cm of H₂O and adjusted to minimize chest retractions. With initial FiO₂ at 48% and was adjusted to maintain SpO₂ (arterial oxygen saturation) between 87%- 95%. Surfactant was administered in babies with moderate RDS whenever needed, after assessing clinically and radiologically, by Insure technique (intubate, surfactant and extubate after 3-5 minutes of IPPV). Downes score was used for evaluating the clinical improvement. The hours of life (before or after 6 hours of life) at which CPAP started was noted, as the study included both Institute delivered preterm newborns and outborn babies. The duration of CPAP delivery was recorded. Bubble CPAP was considered to be successful if the respiratory distress improved and the baby could be successfully weaned off from CPAP.

The criteria for weaning of CPAP-

- absence of Respiratory distress (Respiratory rate between 30 to 60/minute and minimal or no chest retractions).

- SpO₂ > 90% on FiO₂ < 30% and PEEP <5cm of H₂O. Babies then shifted on oxygen and tapered off. [10]. Infants were diagnosed to have failed CPAP and were started on mechanical ventilation when

- SpO₂ < 87% with FiO₂ 70% and PEEP 7cm H₂
- Prolonged and recurrent apneas. Infants failing in the first 1 week of life were considered CPAP

Ethical clearance was obtained from the institutional Ethical Review Committee.

Statistical analysis: Data compilation was done in Microsoft Excel and analyzed by using IBM SPSS software version 22. The categorical data were analyzed by using chi-square tests, while the results of numerical data were expressed as frequency or percentage and a P-value of <0.05 was considered as statistically significant.

Results

A total of 73 preterm Newborn with mild or moderate distress were studied and were put on Bubble CPAP. Most of the neonates were delivered by Caesarean section 48(65.75); 24.66% were of low birth weight. There were 29(39.73%) male infants out of them, 18(62.07%) were successfully weaned off, while 11(37.93%) landed in the failure group. Out of 44 (60.27%) female infants, 35(79.55%) treated successfully with CPAP, while 9 (20.45%) failed to respond. (Table 1&2) In the mothers, 44 (60.27%) mothers received complete 2 doses of antenatal steroids and the success rate of B-CPAP was 40(90.90%) among their preterm infants. While 14 (19.18%) mothers received partial, only one antenatal steroid dose and among them 8(57.14%) preterm were successfully weaned off and 6(42.86%) failed; and 15(20.55%) mothers did not receive any antenatal steroids and among them 10 (66.67%) preterm failed to respond on B-CPAP and 5(33.33%) were successfully treated (Table 1& 2).

There were 42 (57.53%) preterm babies who delivered to our institute and put on CPAP within 6 hours of life. Around 31(42.47%) preterm babies are born outside the institute, among them 12 preterm babies received within 6 hours of life and put on CPAP immediately and 19 babies after 6hrs of life. (Table 2) Surfactant was given to 26 (35.61%) preterm babies by INSURE method. Out of 73 preterm infants, 22(30.14%) were suffering from mild RDS and 51(69.86%) were with Moderate RDS.

In the mild RDS group, 19(86.36%) were treated successfully with B-CPAP, and 3 (13.64%) failed to respond. In the moderate RDS group, 34(66.67%) were successfully weaned off from B-CPAP, while 17 (33.33%) failed to respond. (Table 2) 20 preterm babies failed to respond to CPAP and shifted on the ventilator. Among them 14 babies survived and 6 died. Reason for death 1 due to IVH (Intraventricular hemorrhage),3 due to sepsis and 2 due to NEC (Necrotising enterocolitis).

Table 1: Baseline characteristics of the preterm newborns and their mothers

Characteristics	Number (%)
Gender	
Males	29(39.73)
Females	44(60.27)
Gestational age	
Gestational age < 31 weeks	12(16.44)
Gestational age 31-34 weeks	39(53.42)
Gestational age 34-37weeks	22(30.14)
Birth weight	
Very low birth weight < 1500grams	18(24.66)
Birth weight 1500-2000grams	43(58.90)
Birth weight >2000grams	12(16.44)
Type of delivery	
Vaginal delivery	25(34.25)
Caesarean section	48(65.75)
Type of RDS	
Mild RDS	22(30.14)
Moderate RDS	51(69.86)
Use of Antenatal steroids	
No antenatal steroids	15(20.55)
1 dose of antenatal steroid	14(19.18)
2 doses of antenatal steroids	44(60.27)

%- percentages

Table 2: Association between clinical variables with the outcome of B-CPAP among preterm newborns

Variables	Outcome		X ² Value	P-Value
	Success Number (%)	Failure Number (%)		
RDS			2.998	0.083
Mild	19(86.36%)	3 (13.64%)		
Moderate	34(66.67%)	17(33.33%)		
Gender			2.684	0.101
Male	18(62.07%)	11(37.93%)		
Female	35(79.55%)	9 (20.45%)		
Gestational age in weeks			3.546	0.170
28-31	7 (58.33%)	5(41.67%)		
32-35	27(69.23%)	12(30.77%)		
Above 36	19(86.36%)	3(13.64%)		

Birth weight in grams			1.019	0.601
1000-1500	12(66.67%)	6(33.33%)		
1501-2000	31(72.09%)	12(27.91%)		
>2000	10(83.33%)	2(16.67%)		
Antenatal steroids			20.724	0.001
No	5(33.33%)	10(66.67%)		
Partial	8(57.14%)	6(42.86%)		
Complete	40(90.90%)	4(9.10%)		
Initiation of B-CPAP			16.513	0.001
Within 6hrs	46(85.19%)	8(14.81%)		
After 6hrs	7(36.84%)	12(63.16%)		

%<- percentages

Discussion

B-CPAP was effective in preventing intubation in preterm newborns with respiratory distress. In the present study, the failure rate is 27.40%. This is one of the few prospective studies on the role of bubble CPAP for mild to moderate RDS in preterm newborns (gestational age 28-37weeks).

A total of 73 preterm newborns with mild or moderate distress were put on bubble CPAP out of which 53 (72.60%) were weaned successfully, while 20(27.40%) were intubated and were considered in the failure group.

Table 3: Comparison of the present study with other studies

CPAP	Present study	Jagdish Koti et al study [11]	Urs et al study [12]	Ajay Sethi et al study[13]	Boo et al Study [14]
Success	72.60%	75%	80%	60%	62%
Failure	27.40%	25%	20%	40%	38%

The failure rate of bubble CPAP varies from 20% to 40% among various studies. In the study by Jagdish Koti et al [11]. 25% of patients failed CPAP during the first week of life. Whereas in the study by Urs et al [12]. 20% of infants failed CPAP. In the study by Ajay Sethi et al [13]. around 40% of the newborn with RDS had failed CPAP, while a study conducted by Boo et al [14]. the failure rate was 38%. The differences may be attributed to birth weight and gestational age of infants enrolled, type of nasal interface, the CPAP device, age of starting CPAP, use of antenatal steroids and surfactant.

In this study outcome of bubble CPAP varies between genders but not statistically significant. There were 44 (60.27%) female infants and 29(39.73%) male infants who required CPAP, Success rate was 79.55% in the female gender, while in the male it was 62.07%.

In a study by Urs et al [12]. the outcome of CPAP did not vary between genders. Sandri et al [15]. have shown a higher need for respiratory support in male infants with RDS.

In the present study observations, the success rate was 69.23% in preterm newborns with 31 to 34 weeks of gestational age and 86.36% in > 34 weeks gestational age. The success rate was 72% in preterm newborns with birth weight 1000g to 1500g and 83.33% in >2000g but not statistically proven. There was 41% failure in preterm newborns with gestational age < 31 weeks and 33.33% failure rate in the group of preterm newborns with <1500 g birth weight.

In Jagdish Koti et al [11]. study there was 27% failure in preterm newborns with gestational age <30 weeks and a 25% failure rate in the group of preterm newborns with < 1500g birth weight.

In Urs et al [12]. study statistically significant success was observed in preterm newborns born between 32 -34 weeks and in infants with birth weight between 1000-1500 g.

In the present study statistically significant success was observed in preterm newborns born to mothers who received complete for 2 doses of antenatal steroids with a success rate of 90.90% and 57% success in partial antenatal steroid use. These observations are similar to Parasuramappa H et al [16]. study who observed 97.8% success in antenatal steroids received a group of preterm newborns and similar to Urs et al [12]. study who observed a 92.8% success rate in the group of preterm newborns born to mothers who received antenatal steroids.

But these studies have not mentioned partial or complete dose of antenatal steroids, while the present study gives observations in both groups separately. There was 66.67% failure in those preterm newborns who born to mothers with no use of antenatal steroids. This finding signifies that there is a need to encourage the appropriate use of antenatal steroids even in peripheral parts to have a better outcome for RDS in preterm newborns.

Age at the time of starting CPAP plays a significant role in the prediction of CPAP success or failure. In the present study it is statistically proven that there was an 85.19% success rate in preterm newborns who received CPAP within 6 hours of life and a 36.84% success rate in preterm newborns who received CPAP after 6 hours.

In Jagdish Koti et al [11]. study it is observed that 75% success rate in preterm newborns who received CPAP within 2.07 \pm 1.6 hours of life. As the present study includes preterm newborns who are born outside the institute and then referred to our hospital for further management the differences are observed.

Bubble CPAP is effective in the management of mild to moderate RDS. In a study by Boo et al [14]. moderate RDS was one of the predictors of failure of CPAP whereas in the study by Urs et al [12]. moderate RDS was successfully managed by bubble CPAP as they initiated Bubble CPAP at Downes score of 4.

Conclusion

To conclude, Bubble CPAP is an effective and safe primary mode of respiratory support in preterm newborns with mild to moderate RDS.

What does this study add?

B-CPAP is more effective with early Initiation and in preterm babies born to mothers with antenatal steroids.

Permission from the Institutional research board (IRB): Institutional ethics committee of Mamata Medical College and General Hospital, Khammam; no. 99/18, dated- 12/1/2018.

Author contribution

SDM, SG: conceptualized, manuscript preparation, acquisition, literature research and statistical analysis; SG,

NV: analysis, manuscript editing and review, SDM, SG provided intellectual inputs to the manuscript; SDM is the guarantor for this paper.

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