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A Study on the use of Early Nasal Continuous Positive Airway Pressure (CPAP) in Preterm Neonates with Hyaline Membrane Disease (Respiratory Distress Syndrome)

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Abstract

Introduction: *HMD is the most common cause of respiratory distress in preterm neonates. Deficiency of pulmonary surfactant is one of the commonest factors contributing to development of RDS. CPAP as non-invasive respiratory support is an excellent option useful to avoid the harmful effects associated with invasive ventilation.*

Objectives

1. *To find the incidence of premature neonates (<37 weeks) in our hospital.*
2. *To find the incidence of HMD premature neonates with gestational age between 28-36Weeks.*
3. *To evaluate the effectiveness of early CPAP in preterm neonates with HMD.*

Materials & Methods: *It is Longitudinal Observational study conducted for 1 year duration from January 2018- December 2018.50 inborn preterm neonates with diagnosed HMD admitted in SNCU, KGH were taken as subjects for this study..*

Results: *CPAP was admitted to 50babies out of total 130 inborn neonates diagnosed with HMD, from the period of 0-6hrs. Outcome with 80% success rate and 20%failed requiring higher mode of ventilation. The mean duration requiring CPAP in success group was 38.5 ± 15hrs with range of 10-72hrs, whereas in failure group it is 9.0±1.7hrs with range of 8-12hrs. The effectiveness of CPAP was found to be 100% in mild HMD, 93% in moderate HMD and was only 46.67% in severe HMD. Out of 10 babies who were ventilated 90% were less than 32wks gestational age.*

Conclusion: *In our study we report that prematurity is the commonest cause for HMD. Its incidence increases with decrease in birth weight & gestational age. Early nasal CPAP is useful in mild & moderate HMD with no significant effective outcome in severe HMD. It is safe, inexpensive and effective means of respiratory support in HMD.*

Introduction

Respiratory distress syndrome (RDS) is the commonest cause of respiratory distress in preterm infants. Deficiency of pulmonary surfactant is one of the most important factors contributing to the development of RDS[1]. In immature lungs, the elevated surface tension resulting from surfactant deficiency leads to alveolar collapse at the end of expiration, atelectasis, uneven inflation and regional alveolar over distension. Typical for HMD is that the clinical signs develop gradually in the first hours after birth. It is assumed that breathing movements of the surfactant deficient lung generate shear

forces to the epithelium of the terminal bronchiole, resulting in epithelial lesions. Subsequently fibrinogen and other serum proteins leak through the epithelial lesions into the alveolar space. These proteins inhibit surfactant function and hence cause progressive alveolar collapse[2] producing the clinical picture of RDS[3]. Lower the gestation, higher is the incidence of RDS, accounting for nearly 80% incidence in preterm infants with gestation less than 28 weeks.

Continuous distending pressure (CDP) has been used for the prevention and treatment of RDS as well as the prevention of apnoea, and in weaning from IPPV. CPAP results in progressive recruitment of alveoli, inflates collapsed alveoli and reduces intrapulmonary shunt[4]. It increases the functional residual capacity (FRC) and in turn gaseous exchange. It reduces inspiratory resistance by dilating the airways. This permits a larger tidal volume for a given pressure, so reducing the work of breathing[5]. It regularizes and slows the respiratory rate. It increases the mean airway pressure and improves ventilation perfusion mismatch. It conserves surfactant on the alveolar surface[6,7].

CPAP is applied via a face mask, nasopharyngeal tube, or nasal prongs, using a conventional ventilator, bubble circuit or CPAP driver. Bubble CPAP is a newer CPAP delivering system. It is CPAP delivered by CPAP system with underwater seal. It has been shown that CPAP delivered by underwater seal causes vibration of the chest due to gas flow under water, which is transmitted to infant's airway. These vibrations simulate waveforms produced by high frequency ventilation[8].

Methodology

The study was conducted at SNCU, King George Hospital, Visakhapatnam

50 Inborn neonates with clinically & radiological diagnosed Hyaline membrane disease (HMD) with gestational age 28-36 weeks admitted to SNCU were subjects for this study.

Inclusion Criteria

- Preterm neonate (28-36weeks)
- RDS having onset within 6 hours of birth
- Skiagram of chest showing either poor expansion with air bronchogram or reticulo-granular pattern or ground glass opacity.

Exclusion Criteria

- All term neonates (>37Weeks age)
- Neonates with congenital malformations.
- Babies born to mothers receiving general anaesthesia, phenobarbitone, Pethidine and other drugs likely to depress the baby.
- Preterm born outside our hospital
- Babies with meconium aspiration syndrome & birth asphyxia.

Statistical Analysis

Babies treated with nasal CPAP treatment were classified into two groups namely success and failure group and comparison between the groups were carried out as follows:

- Proportions were compared using chi-square (χ^2) test of significance. Proportion of cases belonging to specific group of parameter or having a particular problem was expressed in absolute number and percentage.
- The results were averaged (mean±standard deviation) for each parameter (duration of treatment, age at admission, age at treatment and ABG parameter) between the groups. Student 't' test was used to find a significant differences between two means.
- In all the above tests, p value <0.05 is considered to be statistically significant.

Results

Total number of deliveries and preterm births (<37 weeks) and incidence of Hyaline Membrane Disease (HMD) in Andhra Medical College during the study period i.e., from January 2018 to December 2018 were determined.

- Total number of deliveries : 4050

- Total number of preterm neonates (<37 weeks): 503
- Incidence of preterm neonates : 12.42%
- Total number of diagnosed HMD cases: 130
- Incidence of HMD in neonates with gestational age between 28-34 weeks: 3.2%
- CPAP was administered to 50 babies from period of 0-6hrs of birth.

Table 1: Nasal CPAP treatment outcome among babies

Total no.of babies treated	SUCCESS		FAILURE	
	Number	Percent	Number	Percent
50	**40**	**80**	**10**	**20**

The table shows the outcome in study group after early nasal CPAP. Among 50 babies, 40 improved with success rate of 80%, 10 (20%) babies failed requiring higher mode of ventilation.

Table 2: Gender distribution among study group

Gender	Success	Failure	Total
Male	24 (75%)	8 (25%)	32
Female	16 (88.8%)	2 (11.11%)	18
	40	10	50
χ^2 = 1.38	df=1	p>0.05 Not significant	

The success rate of 75% (24) is seen in males & 88.88% (16) in females

Table 3: Effect of CPAP on babies based on gestational age

Gestational age (weeks)	Total	Success	Failure
28-30	12	5 (41.67%)	7 (58.33%)
31-32	30	28 (93.30%)	2 (6.67%)
33-34	8	7 (87.50%)	1 (12.50%)
	50	40 (80%)	10 (20%)

χ^2 =14.50 df=2 p>0.001

Higher the gestational age more is the success rate with statistically significant difference between success & failure groups.

Table 4: Effectiveness of CPAP based on time (mean duration of treatment in hours)

Group	Number	Hours (range)	Mean ±*SD*
Success	**40**	**10-72**	**38.5± 15.40**
Failure	**10**	**8-12**	**9.0± 1.70**

The ideal duration to wean off from CPAP was determined from the above results documented. The mean duration in success group was 38.5±15.4 hours with range being 10-72 hours. Similarly mean duration of treatment in failure group was 9.0±1.7 hours range being 8-12hours.

Table 5: Effect of CPAP on SA (Silverman Anderson) score

Total no.of babies	SA score before CPAP	SA score after 6hours of CPAP				
		2	3	4	6	7
16	**4**	5(31.2%)	7(43.8%)	0	4(25%)	0
34	**≥5**	2(5.90%)	18(52.9%)	8(23.5%)	5(14.7%)	1(2.90%)
50		7(14%)	25(50%)	8(16%)	9(18%)	1(2%)

χ^2 =24.50 df=8 p<0.005 (significant)

Out of 16 babies who were in SA score 4, 5 babies improved to score 2, 7 babies to score 3 and remaining 4 babies worsened to SA score of 6 and required ventilation. Out of 34 babies who had a score of ≥5 before nasal CPAP, 2 babies improved to score 2, 18 babies improved to score 3, 8 babies improved to score 4 after 6 hours of nasal CPAP. So there is statistically significant improvement with early nasal CPAP in SA Score.

Table 6: Effect of CPAP on ABG analysis

ABG parameters	Before early nasal CPAP mean± *SD*		After early nasal CPAP Mean ± *SD*	
	Success	Failure	Success	Failure
pH	7.26±0.079	7.31±0.109	7.37±0.0	7.31±0.118
't' value	1.433		2.00	
'p' value	0.178		0.073	
PO2	57.66±10.58	55.93±10.96	80.48±7.5	42.16± 18.83
't' value	0.451		6.309	
'p' value	0.659		0.001	
PCO2	41.31±11.14	36.99±10.42	30.62±6.6	38.40±9.73
't' value	1.147		2.389	
'p' value	0.270		0.036	
HCO_3^-	18.37±0.97	18.56±0.81	20.50±1	17.15±0.83
't'value	0.64		10.82	
'p'value	>0.05		<0.001	

The results showed significant increase in oxygenation & bicarbonate levels indicating the positive effect of CPAP on neonates.

Table 7: Effect of CPAP on babies categorised based on HMD

HMD grading	Success	Failure	Total
Mild	6 (100%)	0	6
Moderate	27(93.10%)	2(6.9%)	29
Severe	7(46.67%)	8 (53.33%)	15
	40	10	50

χ^2=15.3 df=2 p<0.005, Significant

The result therefore suggests the usefulness of CPAP in mild and moderate HMD babies. In severe grade HMD the success rate was only 46.67%.

Table 8: Effect of antenatal steroids in outcome

Steroids received	Success	Failure	Total
YES	26 (92.86%)	2(7.14%)	28
NO	14(63.63%)	8(36.37%)	22
	40	10	50

χ^2=6.5 df=1 p<0.05, Significant

It is found that success rate was 92.86% in babies of mothers who had received antenatal steroids, whereas only 63.63% of the babies in whose mothers did not receive antenatal steroids (statistically significant p<0.05). Hence, antenatal steroids in mother had definite role in better outcome of HMD when treated with CPAP.

Discussion

The incidence of prematurity in our study is 12.42% as compared to National Statistics of 10-12% in India[10]. The incidence of HMD in this study is 3.2%. According to NNPD 2002-03 report[9] the incidence of HMD in our country was 1.3% of all live births. In our study50 preterm babies with gestational age 28 – 34 weeks with HMD were treated with early nasal CPAP. Out of 50, 40 babies (80%) were effectively managed with early nasal CPAP alone. Remaining 10 (20%) had to be intubated and required more invasive mechanical ventilation

Out of 10 babies who required ventilation 90% of the babies were less than 32 weeks gestation age; remaining 10% were between 33-34 weeks. Analysis of these results showed that outcome is better with increased gestational age (p<0.005). Jacobsen et al[11] have shown better outcome in babies with gestational age of <33 weeks. They found significant reduction in mechanical ventilation from 76% to 35% (p=0.00001).

Blood gas analysis was the other parameter, which helped us to decide success and failure on early nasal CPAP. A study by Harris H et al[12] found a significant improvement in mean PaO2 (from 47 to 80 mm Hg; p<0.001) with no significant change in PaCO2 or pH.

Boo NY et al[13] in a recent study determined the predictors associated with failure of nasal continuous positive airway pressure (CPAP) in the treatment of respiratory distress syndrome (RDS). They showed that only three risk factors were significantly associated with failed CPAP. These were: moderate or severe RDS (odds ratio 5.9; 95%; CI 1.5-50.7); and pneumothorax during CPAP therapy (odds ratio 6.9; 95%; CI 1.1-41.7). In our study 80% of the babies who failed had severe RDS.

A success rate of 92.86% was found in babies of mothers who had received antenatal steroids with 'p' value<0.05 (significant) in our study. Sandri F et al[14] has shown trend towards greater failure in babies who had not received antenatal steroids (p=0.02).

Conclusion

In developing countries like ours, there is high burden of prematurity and sub-optimal use of antenatal steroid administration resulting infrequent HMD. In our study, we report that prematurity is the commonest predisposing factor for HMD. Its incidence increases as gestational age decreases. Early nasal CPAP is useful in mild and moderate grade HMD. It may not be a replacement for assisted respiratory support (ventilation) in severe HMD. Nasal CPAP is found to be effective in babies of mothers who had received antenatal steroids. Nasal CPAP is safe, inexpensive and effective means of respiratory support in HMD. Use of early nasal

CPAP which is simple, non-invasive, has low capital outlay and does not require expertise, is the option for us where most places cannot provide invasive ventilation

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