Original Research Article

Study of continuous positive airway pressure (CPAP) ventilation in newborns admitted to tertiary care center

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Abstract

Background: The advent of less invasive CPAP has permitted early treatment of RDS in neonates with aims to intervene as early as possible and to avoid intubation and reduced mucociliary flow and risk of mucosal injury or secondary infection and to minimize volutrauma to the airways and lung parenchyma. In present study we aimed to study continuous positive airway pressure (CPAP) ventilation in newborns admitted to our tertiary care center. **Material and Methods:** Present study was a prospective observational study conducted in new born babies clinically diagnosed with respiratory distress (HMD) with gestational age 28-36 weeks admitted to Neonatal ICU, required CPAP After the completion of the study, data was analyzed using appropriate statistical methods to find out the effectiveness of nasal CPAP in the treatment of preterm infants with respiratory distress with (HMD). **Results:** Out of total 50 babies who were managed with early nasal CPAP, it proved effective in 42 babies (84%), remaining 9 babies (18%) had to be intubated and required ventilation. The results were analyzed based on gender, gestational age and birth weight characteristics and found no statistically significant difference in the outcome between the two groups ($p>0.005$). A statistically significant improvement ($p<0.005$) in Downes score after application of nasal CPAP. Babies on CPAP had significant improvement in oxygenation ($p<0.05$), other parameters varied. Babies were studied based on radiological appearance and we found a success rate of 93.1% in moderate grade HMD (statistically significant $p<0.005$). Mortality rate was more in the failure group which is 50% compared to success group, $p<0.05$, significant. Shifting mechanical ventilation from the failure group 88.8% compared to success group i.e. 11.1%. Compared to failure and success group complications were more seen in failure group p-value <0.001 highly significant. **Conclusion:** Nasal CPAP is found to be effective in babies with low birth weight with preterm with respiratory distress (HMD). Nasal CPAP is safe, inexpensive and effective means of respiratory support in HMD. Early nasal CPAP is useful in mild and moderate grade HMD.

Keywords: ventilation in newborns, Respiratory distress syndrome, Bubble CPAP, CPAP failure.

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INTRODUCTION

Intermittent positive pressure ventilation (IPPV) with surfactant is the standard treatment for RDS. Although varying degrees of success was reported with assisted ventilation as therapy for RDS, in all series mortality was high when infants were less than 1500 grams or required ventilation before 24 hours of age.[1] The major difficulty with IPPV is that it is invasive and contributes to airway and lung injury including the development of chronic lung disease. The advent of less invasive CPAP has permitted early treatment of RDS in neonates with aims to intervene as early as possible and to avoid intubation and reduced mucociliary flow and risk of mucosal injury or secondary infection and to minimize volutrauma to the airways and lung parenchyma. Continuous distending pressure (CDP) has been used for the prevention and treatment of RDS as well as the prevention of apnea, and in weaning from IPPV. CPAP results in progressive recruitment of alveoli, inflates

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collapsed alveoli and reduces intrapulmonary shunt.[2,3] It increases the 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.[4] It reduces the compliance of very compliant lungs and in these lungs, reduces the tidal volume and minute volume. 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.[5,6] In present study we aimed to study continuous positive airway pressure (CPAP) ventilation in newborns admitted to our tertiary care center.

MATERIAL AND METHODS

Present study was a prospective observational study conducted at Bapuji Child Health Institute and Research Center, Chigateri General Hospital, Women and Children Hospital attached to J.J.M. Medical College and Hospital, Davangere. Study duration was of 2 years (from November 2011 to November 2013).

Inclusion criteria

All new born babies clinically diagnosed with respiratory distress (HMD) with gestational age 28-36 weeks admitted to Neonatal ICU, required CPAP for conditions like.

Respiratory distress syndrome, Transient tachypnea of the newborn, Meconium aspiration syndrome, Primary pulmonary hypertension, Pulmonary hemorrhage, Patent ductus arteriosus, Apnea of prematurity.

Exclusion criteria

Upper airway abnormality like cleft palate, choanal atresia, tracheoesophageal fistula. Severe cardiovascular instability. Recurrent apneic episodes not responding to CPAP. Severe ventilatory impairment (pH <7.25 and paCO2 > 60 mmHg).

Study was explained and a written informed consent was taken from parents. Clinical, demographic details of newborn babies admitted to NICU, required CPAP were collected. Follow up was kept till 2 weeks from discharge. Various details such as effectiveness, mortality, morbidity, complications and outcome – Success of CPAP, Changes in Downes score, Shifting to mechanical ventilator, Changes in ABG parameter were noted. CPAP successful when: The saturation is >85%, PaO2 of 60-80 mmHg, paCO2 of 25 to 45 mmHg and pH of 7.3 to 7.4 with FiO2 <0.6. Baby has no respiratory distress.

CPAP failure is defined as:

- PO2 < 50 mmHg or PCO2 > 60 mmHg with FiO2 > 0.6 and pH <7.25.
- Downes score >7
- Recurrent apnea.

After the completion of the study, data was analyzed using appropriate statistical methods to find out the effectiveness of nasal CPAP in the treatment of preterm infants with respiratory distress with (HMD). 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's 't' test used to find a significant difference between two means. In all above test, 'p' value of less than 0.05 was accepted as indicating statistical significance.

RESULTS

Among 50 babies, 42 improved with success rate of 84%, whereas 8 babies (16%) failed requiring higher mode of ventilation. We found a success rate of 78.10 in male sand 94.40% in females. (p>0.005).

Table 1: Nasal CPAP treatment effectiveness (success /failure) among babies

Gender	Total	Success (%)	Failure (%)
Male	32	25 (78.10 %)	7 (21.90 %)
Female	18	17 (94.40 %)	1 (5.60 %)
Total	**50**	**42 (84 %)**	**8 (16 %)**

χ^2=2.83, df=1, p>0.05, (not significant)

In babies who were between 28-30 weeks there is 63.60% success and 36.40% failure rate. In babies of 31-32 weeks gestation 90% and 10% success and failure respectively. Among 33-34% weeks success rate 88.90% failure rate 11.10% and 35-36 weeks gestation success rate 100% and failure rate 0.00%. There is no statistically significant difference between success and failure groups with respect to gestational age (p<0.005).

Table 2: Distribution of babies based on gestational age and results

Gestational age in weeks	Total	Success (%)	Failure (%)
28-30	32	7 (63.6 %)	4 (36.4 %)
31-32	11	18 (90 %)	2 (10 %)
33-34	20	16 (88.9 %)	2 (11.1 %)
35-36	18	1 (100 %)	0
Total	**1**	**42 (84 %)**	**8 (16 %)**

χ^2=4.440, df=3, p>0.05, (not significant)

In babies who were <999 gm 63.70 were managed with nasal CPAPA alone and 33.30% failed. Effectiveness in 1000-1500 gm group were 77.30% and 22.70% success and failure rates respectively. In babies 1501-2000 gm success and failure rate 100% and 0% respectively and in >2000 gm success and failure rate 83.30% and 16.70% respectively. Success and failure rate are not significantly different with respect to birth weight.

Table 3: Distribution and effectiveness of babies based on birth weight

Birth weight in gms	Total	Success (%)	Failure (%)
<999	3	2 (66.7 %)	1 (33.3 %)
1000-1500	22	17 (77.3 %)	5 (22.7 %)
1501-2000	13	13 (100 %)	0
>2000	12	10 (83.3 %)	2 (16.7 %)
Total	**50**	**42 (84 %)**	**8 (16 %)**

χ^2=3.892, df=3, p>0.05, (not significant)

The mean duration in success group was 48.6±16.3 hours with range of 24-72 hours similarly mean duration of treatment in failure group was 18.0±6.4 hours range being 12-24 hours. The mean age for initiation of treatment is 10.6 hours with range of 1hour – 120 hours.

Table 4: Mean duration of treatment (hours)

Group	Number	Mean ± SD	Range (hours)
Success	42	48.6±16.3	24-72 hours
Failure	8	18.0±6.4	12-24 hours
Total	**50**	**10.6 ± 19.3**	**1 hr. – 120 hrs.**

t=5.18, p<0.001 (highly significant)

2% had Downes score score 4, 18% were in score 5, 80% were in score 6 before institution of CPAP. Nasal CPAP was started when score was 4 or more. 6 (12.2%) babies deterioted to score 6 after 6 hours of nasal CPAP (statistically significant p<0.001).

Table 5: Downes score in study before and after group

Downe's score	Before CPAP (%)	After 6 hours (%)	12 hours (%)	72 hours (%)
1	--	--	--	9 (18%)
2	--	1 (2%)	10 (20%)	--
3	--	6 (12%)	23 (46%)	--
4	1 (2%)	30 (60%)	8 (16%)	--
5	9 (18%)	7 (14%)	1 (2%)	--
6	40 (80%)	6 (12%)	4 (8%)	--
7	--	--	4 (8%)	--
-	--	--	--	41 (82%)
Total	**50**	**50**	**50**	**50**

A significant increase in oxygenation (p<0.05) was noted after application of nasal CPAP.

Table 6: Comparison of ABG parameters before and after treatment

ABG parameter	Before early nasal CPAP (mean±SD)		After early nasal CPAP (mean±SD)	
	Success group	Failure group	Success group	Failure group
pH	7.32±0.05	7.29±0.04	7.41±0.09	7.17±0.8
't' value	1.436		7.088	
'p' value	0.158, NS		<0.001, HS	
PO_2	83.53±11.41	69.19±14.90	90.60±15.16	77.94±14.31
't' value	3.104		2.182	
'p' value	0.003, S		0.034, S	
PCO_2	30.08±10.51	40.44±8.95	22.97±13.86	39.14±11.29
't' value	-2.607		-3.101	
'p' value	0.012, NS		0.003, S	
HCO_3^-	18.06±3.06	17.41±1.94	18.39±3.52	17.05±2.37
't' value	0.571		1.031	
'p' value	0.571, NS		0.308, NS	

4 babies having ROP in success group, pneumothorax in 1 baby in success group, apnea in 7 babies out of which 4 (9.5%) babies in success group and 3 (37.5%) babies in failure group, shock in 1 (12.5%) baby having failure group and pulmonary hemorrhage 3 (37.5%) cases in failure group. Compared to failure and success group complication is more seen in failure group p-value <0.001 highly significant.

Table 7: Study of complications and morbidity

Complications	Total	Success (n=42)	Failure (n=8)
Retinopathy of prematurity (ROP)	4	4 (9.5%)	0
Pneumothorax	1	1 (2.4%)	0
Apnea	7	4 (9.5%)	3 (37.5%)
Shock	1	0	1 (12.5%)
Pulmonary hemorrhage	3	0	3 (37.5%)

Z-value 9.17, p-value <0.001, HS

DISCUSSION

Literature review shows varying results with administration of CPAP in managing HMD and results differ based on different modes of CPAP used. Kamper *et al.*[7] found success rate of 84% in HMD with CPAP system used with a binasal tube. In a study by Gitterman *et al.*[8] early use of nasal CPAP in VLBW showed significant reduction in intubation rate after introduction of nasal CPAP (30% vs 53%, p=0.016). Another study by Narendran V, *et al.*[9] showed early bubble CPAP reduced the need for mechanical ventilation (p<0.001) with no increased complications. One study by Nair *et al.*[50] showed failure rates of 10.7% in newborns with respiratory disease. They used nasal CPAP using Benvenist's valve. In another recent study by Urs *et al.*[10] CPAP proved to be effective in 80% cases with HMD and found no statistically significant difference in outcome between males and females. Study by Sandri F, *et al.*[11] has shown higher need for respiratory assistance in male infants. Urs *et al.*[10] have found better outcome in gestational age of 32-34 weeks. They found significant reduction in mechanical ventilation from 76% to 35%. Nasal CPAP management increased in the surviving infants over time, whereas the need for surfactant treatment decreased. Studies have shown better outcomes in VLBW and ELBW. Aly H *et al.*[12] studied outcome of nasal CPAP in ELBW. They found no significant trends in mortality rate among the baseline group and the 3 groups after the institution of the nasal CPAP practice. Study by Narendran V *et al.*[9] has also shown better outcomes in ELBW. Another study by Joris N *et al.*[13] has shown significant reduction in intubation rate in babies < 1500 g (from 72.1% to 30.8%; p<0.01). In our study we did not find any significant difference in the outcome of babies based on birth weight (p>0.0()5). Urs *et al.*[10] have shown better outcome in babies with birth weight 1000-1500 gm (p<0.001). Recent study showed, infants who received CPAP in circumstances where NICU access was denied had a significantly improved short-term survival (at 24 hours), with trends towards improved long-term survival. Ur *et al.*[10] have shown significant improvement in Downes score after application of bubble CPAP. Blood gas analysis was the other parameter, which helped us to decide success and failure on early nasal CPAP. In our study we found that babies on CPAP had significant improvement in oxygenation (p<0.05), other parameters varied. With this we could reduce FiO_2 significantly and wean down the babies. Among 10 babies who required ventilation, PO_2 levels before CPAP were (83.53±11.41) and after CPAP (90.60±15.16). One study by Schmid R *et al.*[14] who analyzed data based on radiological appearance and showed that CPAP was an effective method in newborns with all grades except severe HMD. Another study by Urs *et al.*[10], conclude that CPAP is effective in mild and moderate grade HMD. Boo NY *et al.*[15] 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 percent; CI 1.5-50.7); and pneumothorax during CPAP therapy (odds ratio 6.9; 95 per cent; CI 1.1-41.7). In our study 80% of the babies who failed had severe RDS. In developing countries like ours, there is high burden of prematurity and low birth weight 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. Infants with white out chest x-ray, Downes score >6, even after initial stabilization on CPAP, higher FiO2 requirement and pulmonary hemorrhage are higher risk of CPAP failure (needing mechanical ventilation). It may not be a replacement for assisted respiratory support (ventilation) in severe HMD. Bubble CPAP is safe, inexpensive and effective means of respiratory support in respiratory distress (HMD).

CONCLUSION

Nasal CPAP is found to be effective in babies with low birth weight with preterm with respiratory distress (HMD). Nasal CPAP is safe, inexpensive and effective means of respiratory support in HMD. Early nasal CPAP is useful in mild and moderate grade HMD.

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