ORIGINAL ARTICLE

SAFETY AND EFFECTIVENESS OF BUBBLE CONTINUOUS POSITIVE AIRWAY PRESSURE IN NEONATES WITH RESPIRATORY DISTRESS AND ITS FAILURE FACTORS

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ABSTRACT

Background: Studies on Bubble Continuous Positive Airway Pressure (B-CPAP) as respiratory support for neonates are few. The aim of our study was to determine the efficacy and safety of B-CPAP in preterm and term neonates requiring respiratory support and to study its failure factors, so we can come out of it and utilize this non-invasive cost effective method widely and successfully.

Methods: A prospective observational study was done on 51babies both term and preterm babies admitted in NICU of SMIMER Hospital, Surat, requiring respiratory support for mild to moderate respiratory distress. Support was given with short nasal prongs with under water seal Bubble C Pap. Surfactant was administered when indicated. Monitoring was done clinically, with pulse oximeter, radiologically and with blood gases.

Result: The mean gestational age of the study population was 32-34 weeks and birth weight was 1.501 g. 53% of the population were Very Low Birth Weight (VLBW) babies weighing less than 1500 g. C-PAP failure rate was higher in these babies. The most common disease for starting B-CPAP was RDS (80%) followed by pneumonia (17%), TTNB (0%) and MAS (2%). The commonest complications on B-CPAP were shock, apnea and nasal damage. Overall failure of BCPAP occurred in 21/51 cases or 40%. All babies who failed BCPAP were put on mechanical ventilation. Failures in RDS group were 18/41 or 43%. Failure rate in the pneumonia group was 3/9 or 33.3%. Higher cases of sepsis and pulmonary haemorrhage were seen in failure group (table2).Overall survival rate of the study population was 60 %.

Conclusion: Bubble Continuous Positive Airway Pressure is safe, efficacious and easy to use in preterm& term neonates with mild to moderate respiratory distress. The major failure factors in our study were sepsis, recurrent apnea, and shock. The survival rate in our study was 60%.

Keywords: Bubble Continuous Positive Airway, Pressure, PEEP, Preterm & Term

INTRODUCTION

Continuous positive airway pressure (CPAP) is an important treatment modality for respiratory distress syndrome (RDS) in neonates. It can be applied via a face mask, nasopharyngeal tube, or nasal prongs, using a conventional ventilator, bubble circuit or a CPAP driver.

Bubble CPAP (bCPAP) is one of the low cost nasal CPAP delivering systems, with underwater seal. CPAP delivered by underwater seal causes vibration of the chest due to gas flow under water; and these vibrations simulate waveforms produced by high frequency ventilation. Lee, et al demonstrated the superiority of bubble CPAP as compared to ventilator derived CPAP in premature infants.[1] Bubble CPAP is also a less expensive method of respiratory

support, most suitable to neonatal units with limited resources in developing countries.[2] We evaluated the effectiveness of bubble CPAP as a simple and non-invasive option in a developing country.

Gregory et al first pioneered the use of Bubble Continuous Positive Airway Pressure (B-CPAP) in Neonatology with their landmark paper in the 70s in Columbia.[3] Bubble CPAP differs from conventional CPAP in that in B-CPAP the expiratory limb is placed under water and oscillatory vibrations are transmitted into the chest resulting in waveforms similar to those produced by high-frequency ventilation.[4]

This modality of respiratory support was relegated to the background with invasive forms of ventilatory support becoming popular in the 80s and 90s.Continuous positive airway pressure (CPAP), often thought to be the 'missing link' between supplemental oxygen and mechanical ventilation, and is gaining immense popularity in neonatal intensive care units. Being technically simple, inexpensive and effective, it has become the primary mode of respiratory support in preterm very low birth weight (VLBW) infants. Despite the lengthy period of time over which B-CPAP has been used, surprisingly little is still known about the importance or relevance of the bubble component of this mode of ventilation and its safety. This study was planned to look at its effectiveness of B-CPAP in reducing mortality and need for invasive ventilation and its safety as a form of respiratory support in preterm babies.[5,6]

METHODOLOGY

A prospective, observational study with B-CPAP was carried out in the NICU of SMIMER Hospital, Surat, Gujarat, India, a tertiary care hospital, on 50 preterm & term babies with respiratory distress to determine the need for invasive ventilation and mortality (primary outcomes). The study was also to know the failure factors, so we can overcome of those and utilize this modality more widely.

Inclusion criteria were preterm & term (38 weeks gestation age) babies with neonates with gestational age 28 weeks to 38 weeks with RDS; Neonates with mild to moderate RDS based on Downe's score & Silverman Anderson score and Neonates with TTNB, MAS, Congenital pneumonia,

Exclusion criteria were neonates with RDS secondary to birth asphyxia, sepsis, NEC; Congenital anomalies like TOF, Cleft lip & Palate, CDH, choanal atresia; Neonates require intubation at birthand severe cardiovascular instability.

Informed consent was taken from parents. Details of birth history, risk factors in the pregnancy, type of delivery and need for resuscitation were recorded. Study babies were put on B-CPAP as the initial formof respiratory supportwithshort, nasal Hudson's cannulae on a stand-alone machine B-CPAP machine. All babies were nursed under radiant warmers on servo-controlled skin mode. B-CPAP was started with 5 cm H2O and FiO2 adjusted to maintain pulse oximeter saturation between 88%e94% in babies <1.5 Kg and 92%-94% in bigger babies. Babies with a diagnosis of RDS were given surfactant if indicated (Downe's score 4e6 or requirement of FiO2 >0.4 CPAP). This was done by INSURE (INtubate, SURfactant Extubate) technique and babies were then put back on CPAP.

Monitoring was done clinically, with pulse oximetry, X-rays and ABGs for requirement of change in settings, complications, failure and outcome. Time of starting CPAP total duration of therapy and time taken to wean were noted.

Weaning off B-CPAP was done when the respiratory distress decreased to Downe's score <3 and ABGs were normal. Trials off B-CPAP (cycling) were done before finally discontinuing.

Failure of B-CPAP was defined as one or more of the following:

a. Requirement of pressure >8 cm H2O
b. FiO_2 requirement >0.6
c. paO_2<50 mmHg on maximum acceptable settings
d. $paCO_2$>60 mm Hg and pH <7.25 on maximum acceptable settings
e. Air leak on B-CPAP
f. Recurrent apnoea on B-CPAP despite caffeine citrate

Data was analysed as mean & SD. Chi square test, Fischer's t test and multivariate analysis were used. Analysis was done on SPSS (ver 11.2).

RESULTS

There were total 51 patients which were put on B-CPAP out of which 60% were weaned successfully while other were intubated and was considered in failure group.

Table 1: Types of respiratory distress (N=51)

Types	Babies Received Nasal CPAP
HMD	41 (80.0)
MAS	1 (2.0)
TTNB	0 (0.0)
Congenital Pneumonia	9 (17.1)
Total	**51 (100)**

Table 2: Comparison of factors affecting CPAP outcome

Variables	CPAP		p-Value
	Success (N=30)	Failure (N=21)	
Birth weight(mean)	1678.33	1362.38	0.89
Male%	16(53.0)	11(52.0)	0.08
ANS(antenatal steroid)	13(60.0)	9(40.0)	1.34
AGE AT CPAP	1 hr	1.08hr	0.55
FIO_2 at 15-20min of CPAP	51.6	51.4	0.75
PEEP at 15-20min of CPAP	5.1	5.9	0.056
Silverman score at 15 min	4.3	6.2	0.044
Max. fio2	60.3	65.71	0.080
Max PEEP	5.8	6.85	0.035
Duration of CPAP	5.06	1.33	0.045
Surfactant	9(52.7)	8(47.0)	0.541
Recurretnt Apnea	1(11.0)	8(38.09)	0.025
Pneumonia	6(66.6)	3(33.3)	0.675

Fingure in parenthesis indicate percentage.

Table 3: Complications on CPAP

Outcome	C PAP		p-Value
	Success (N=30)	Failure (N=21)	
Nasal Damage	1(2.0)	0	-
Pneumothorax	0	0	-
IVH/PVL	0	0	-
Shock	1(3.3)	16(76.2)	0.002
Sepsis	2(6.66)	16(76.2)	0.004
Pulmonary H'ge	0	8(38)	0.005

Fingure in parenthesis indicate percentage.

Table 4: Outcome of CPAP (N=51)

Outcome	Babies received CPAP (%)
Discharge	30(60.7)
DAMA	0
Death	21(40.3)

The mean gestational age of the study population was 32-34 weeks and birthweight was 1.501 g. 53% of the population were Very Low Birth Weight (VLBW) babies weighing less than 1500 g. C-PAP failure rate was higher in these babies.

The most common disease for starting B-CPAP was RDS (80%) followed by pneumonia (17%), TTNB (0%) and MAS (2%). Patients who received ANS were having higher cpap success rate. There was no difference in the result with the age of onset of CPAP in our study. The mean maximum pressure on B-CPAP was 6.34 cm of h2o which was significant and mean maximum fio2 was 62.85.maximum PEEP and FIO2 at 15 min was similar in both the groups. The Silverman score was more in failure group indicating failure associated with severity of the disease. The patients who received surfactant were having less failure rate. The duration of stay on CPAP was more in success group (table2).

The commonest complications on B-CPAP were shock, apnea and nasal damage. Overall failure of BCPAP occurred in 21/51 cases or 40%. All babies who failed BCPAP were put on mechanical ventilation. Failures in RDS group were 18/41 or 43%. Failure rate in the pneumonia group was3 /9 or 33.3%.Higher cases of sepsis, pulmonary haemorrhage was seen in failure group (table3).Overall survival rate of the study population was 60 %(table 4).

DISCUSSION

30 patient out of 51 (60.00%) who was treated with CPAP were considered successful treatment which is lower than that founded by shamil et al(66%).[7] It may be lower due to higher incidence of sepsis in our study.

Gupta et al. did a randomized controlled trial to compare BCPAP with variable flow CPAP on 140 preterm infants of 24-29 weeks' gestational age and 600-1500 g. The authors concluded that there was no difference in the success of extubation between the two.[8]Success was higher in patients with ANS given however No significances was found for antenatal steroid (p-Value=0.148) in our study which is not the situation in URS, et al. (p-Value=0.001).[9]

CPAP, and found a 38% failed CPAP and required ventilator support , which is higher than that found in our study (33.33%); with only+ 34% of the infants in their study received antenatal steroids and the authors did not report the usage of surfactant in their study. KOTI, et al conduct a retrospective analytic study on 56 neonate (28-34 weaks); only 14 (25%) patient considered as CPAP failure which is lower than that found in our study i.e. 21out of 63 (33.33%) taking in account the differences in birth

weight and gestational age of infants enrolled, type of nasal interface, the CPAP device, age of starting CPAP, and use of antenatal steroids and surfactant.[10] In our study we found that the age of neonate at which CPAP had been applied median = 2 (0.3-6) hours of life is a significant contributor for the CPAP failure (P=0.024) which is different from that found by Koti et al (P value=0.58). Although septicemia and apnea predicted CPAP failure in our study too, pneumothorax was seen in 2 babies in the success group which is unlike that founded by Ammari et al.[11]

Respiratory Distress Syndrome remains the most common indication for use of CPAP in neonates the world over. This was also the case in our study. Verder et al. published the first randomized controlled trial of surfactant instillation during nCPAP showing that in infants with moderate-to-severe the need for subsequent mechanical ventilation could be reduced by half after a single dose of surfactant.[12]The effect was even more pronounced if the surfactant treatment was given early in the course of the disease. In our study 56% of babies diagnosed with RDS were given exogenous surfactant. Of these, 8/17 (43%) failed CPAP. Indian studies on CPAP have shown a failure rate of 25-50%. In a study comparing IPPV and CPAP in about 150 preterm babies between 32 and 34 weeks CPAP did not provide adequate respiratory support in 22 newborns (26%). Of these, 17 received IPPV, five of whom died.[13] In our study also there was failure rate of 40% which was higher than the above study.

In our study 21 cases failed CPAP of which 18 were RDS cases. Overall failure rate seen in our study was 40% and in RDS it was 43% which was similar to other studies. Our study showed that during B-CPAP there was a good normalization of ABGs. This is consistent with other studies.[14] In a landmark study (COIN Study) Morley et al. looked at early CPAP for tiny babies between 25 and 28 weeks of gestation. They found that early nasal CPAP significantly reduced the need for intubation but did not significantly reduce the rate of death or Broncho pulmonary dysplasia, as compared with mechanical ventilation. Even though the CPAP group had more incidences of pneumothorax, fewer infants received oxygen at 28 days, and they had fewer days of ventilation.[15]

In our study it shows that in immediate outcome recurrent apnoea is more in failure group, also shock is higher in failure group in immediate outcome. In koti et al study apnoea as immediate outcome is more as compared to our study. The overall survival rate was 60% which was lower compared to other studies as we had more preterm and VLBW babies and due to high prevalence of sepsis in our set up.

In conclusion, use of B-CPAP in preterm babies is safe and results in decreased requirement of ventilation in cases of respiratory distress syndrome and pneumonia. The major failure factors in our study were sepsis, recurrent apnea, and shock.

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