

Comparative Study of Incidence and Severity of Nasal Complications While using Nasal Prongs and Nasal Mask as CPAP Interface in Preterm Neonates: An Experimental Study

Manoj Kumar Ram¹, Anup Kumar², Alka Singh³

¹Assistant Professor, Department of Pediatrics, NMCH, Patna, Bihar, India

²Assistant Professor, Department of Pediatrics, Government Medical College, Bettiah, Bihar, India

³HOD, Department of Pediatrics, NMCH, Patna, Bihar, India

Received: 21-01-2023 / Revised: 20-02-2023 / Accepted: 04-03-2023

Corresponding author: Dr. Anup Kumar

Conflict of interest: Nil

Abstract

Aim: This study was conducted to compare the outcome of nasal prong and nasal mask interfaces in preterm infants on CPAP support due to respiratory distress.

Methods: A randomized controlled trial was performed at Department of pediatrics, NMCH, Patna, Bihar, India for the period of one year.

Results: A total of 148 preterm infants were assessed for eligibility to the study of which 28 newborns were excluded from the study as they did not meet the inclusion criteria. A total of 120 babies were enrolled in the study, of which 12 babies were ventilated due to CPAP failure and 8 babies left against medical advice before the study could be completed and hence were excluded. Finally, 100 participants completed the study. 50 participants were enrolled in Group A (nasal prongs) and 50 in Group B (nasal masks). The mean duration of CPAP administration in Group A (nasal prongs) was 4.536 ± 0.86 days and in Group B (nasal masks) was 5.205 ± 0.614 days ($P = 0.0778$). Babies in Group A had an average hospital stay of 21.36 ± 5.14 days, and babies in Group B had hospital stay of 24.58 ± 7.31 days ($P = 0.7900$). CPAP failure was seen in 10 (20%) babies in Group A and 11 (22%) babies in Group B ($P = 0.7395$).

Conclusion: Based on our study, we concluded that the use of binasal prongs and nasal masks as interface during CPAP therapy makes no difference in overall outcome of nasal trauma in the patient. Both were found equally effective and comparable to each other.

Keywords: Continuous Positive Airway Pressure, Nasal Mask, Nasal Prongs, Nasal Trauma.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Respiratory support in the neonatal intensive care unit (NICU) is a mainstay to reduce complications of invasive mechanical ventilation. Nasal Continuous Positive Airway Pressure (CPAP) in infants is used for situations such as respiratory distress syndrome, apnea of prematurity, bronchomalacia with terminal

airway collapse, and in other conditions that require positive pressure. Types of CPAP used in neonates include continuous low CPAP, variable flow CPAP, bubble or underwater seal CPAP, bi-level CPAP, synchronized non-invasive positive pressure ventilation, high flow nasal cannula, and nasal high frequency

ventilation (NHFV). To apply CPAP, three components are essential required continuous flow of a heated and humidified gas mixture (compressed air and oxygen); a system connecting the device to the patient's airway such as facial masks, nasal prongs, nasopharyngeal or endotracheal tubes and a mechanism of positive pressure generation in the system. [1]

Non-invasive respiratory support in the neonatal intensive care unit (NICU) has been used for more than 35 years as a means to reduce complications of invasive mechanical ventilation. Specific types of non-invasive support have been implicated in preventing respiratory failure in spontaneously breathing infants, especially those with Respiratory Distress Syndrome (RDS). Technological progress, along with a better understanding of the applications of equipment, advances in the care of the neonate, and documented favourable patient outcomes have translated into trends that continue to promote non-invasive respiratory support for care of the neonate.

The local pressure of CPAP devices to the nasal area tends to develop decubitus lesions in the newborn due to its cutaneous vulnerability and anatomical factors such as endovascularisation of the columella and nostrils. [2,3] Nasal trauma represent a source of discomfort for patients, possible site of infection and a risk of long term functional or cosmetic sequelae. [4-6] Respiratory distress in newborn babies is one of the commonest causes of Neonatal intensive care unit (NICU) admissions (30-40%). [7] Bubble CPAP is a simple, cost effective and non-invasive method of ventilating sick newborns. [8] It is a well-established mode of respiratory support in preterm babies. Early use of CPAP for stabilization of at-risk preterm infants reduces ventilator needs. Nasal prongs and nasal masks are being frequently used as interface between patients.

This study was conducted to compare the outcome of nasal prong and nasal mask interfaces in preterm infants on CPAP support due to respiratory distress.

Methods

A randomized controlled trial was performed at Department of pediatrics, NMCH, Patna, Bihar, India for the period of one year. A total of 148 preterm infants were assessed for eligibility to the study of which 28 newborns were excluded from the study as they did not meet the inclusion criteria. A total of 120 babies were enrolled in the study, of which 12 babies were ventilated due to CPAP failure and 8 babies left against medical advice before the study could be completed and hence were excluded.

Preterm infants of gestational age 28–34 weeks with moderate respiratory distress (according to Silverman score) admitted within 6 h of life, requiring CPAP, were enrolled in the study after getting informed written consent. Babies with 5-min Apgar scores <5, major congenital malformation/anomalies, and severe sepsis/meningitis/ metabolic disorders were excluded from the study. The study protocol was approved by the Ethics Committee of the institute.

After initial stabilization, the treatment plan was delineated. Babies requiring bubble CPAP support were randomized using Tippett's random number table to one of the two groups according to the interface used to provide CPAP (Group A: binasal prongs and Group B: nasal masks). Scoring for severity of respiratory distress in preterm infants was done using the Silverman–Anderson score.⁹ Outcomes were measured in different parameters. Nasal trauma was assessed when the interface was transiently removed for suctioning or cleaning.

Data were collected on structured per forma and managed using MS Excel software. Statistical analysis was

performed using one-way ANOVA F-test at 1% level of significance. Statistical significance was considered if $P < 0.01$. The quantitative data were expressed in

mean \pm standard deviation (SD), and qualitative data were expressed in terms of frequency distribution.

Results

Table 1: Comparison of general characteristics of study participants

	Nasal prongs (n=50)	Nasal masks (n=50)	P
Gestational age (weeks), mean \pm SD	30.475 \pm 2.018	30.245 \pm 2.021	0.8950
Birth weight (g)	1180 \pm 0.22	1182 \pm 0.21	0.7554
Gender			
Male	38 (76)	34 (68)	0.0984
Female	12 (24)	16 (32)	0.2334
Mode of delivery			
Vaginal	39 (78)	35 (70)	0.4221
Cesarean	11 (22)	15 (30)	0.4996
Place of delivery			
Home	12 (24)	15 (30)	-
Institutional	38 (76)	35 (70)	-
Assessment of respiratory distress/Silverman score			
4	15 (30)	15 (30)	-
5	15 (30)	16 (32)	-
6	20 (40)	19 (38)	-
Surfactant instillation			
Surfactant received	26 (52)	29 (58)	0.781
Surfactant not received	24 (48)	21 (42)	0.720
Administration of antenatal steroids			
Given	17 (34)	23 (46)	-
Not given	33 (66)	27 (54)	-

A total of 148 preterm infants were assessed for eligibility to the study of which 28 newborns were excluded from the study as they did not meet the inclusion criteria. A total of 120 babies were enrolled in the study, of which 12 babies were ventilated due to CPAP failure and 8 babies left against medical advice

before the study could be completed and hence were excluded. Finally, 100 participants completed the study. 50 participants were enrolled in Group A (nasal prongs) and 50 in Group B (nasal masks). The baseline characteristics of both groups were comparable to each other.

Table 2: Comparison of outcomes during continuous positive airway pressure therapy

Parameters	Nasal prongs (n=50)	Nasal masks (n=50)	P
Mean duration of CPAP (days) \pm SD	4.536 \pm 0.86	5.205 \pm 0.614	0.0778
Duration of hospital stay (days) \pm SD	21.36 \pm 5.14	24.58 \pm 7.31	0.7900
CPAP failure	10 (20)	11 (22)	0.7395
ROP	4 (8)	5 (10)	0.1384
NEC	4 (8)	5 (10)	0.1384
PDA	3 (6)	3 (6)	0.1248
Nasal trauma	23 (46)	22 (44)	0.5372

The mean duration of CPAP administration in Group A (nasal prongs) was 4.536 ± 0.86 days and in Group B (nasal masks) was 5.205 ± 0.614 days ($P = 0.0778$). Babies in Group A had an average hospital stay of 21.36 ± 5.14 days, and babies in Group B had hospital stay of 24.58 ± 7.31 days ($P = 0.7900$). CPAP failure was seen in 10 (20%) babies in Group A and 11 (22%) babies in Group B ($P = 0.7395$). About 8% (4) babies in Group A and 10% (5) babies in Group B developed retinopathy of prematurity (ROP) ($P = 0.1384$). Four (8%) babies in Group A and 5 (10%) babies in Group B developed necrotizing enterocolitis (NEC) during CPAP therapy ($P = 0.1384$). The development of patent ductus arteriosus (PDA) was observed in 3 (6%) babies in Group A and 3 (6%) babies in Group B ($P = 0.1248$). Nasal trauma was observed in 46% (23) babies in Group A and 44% (22) babies in Group B during CPAP therapy ($P = 0.537$).

Discussion

Nasal continuous positive airway pressure is the primary mode of therapy in preterm neonates especially in hyaline membrane disease. It reduces the need of ventilator, surfactant and invasive ventilation associated risks. [10] Use of continuous positive airway pressure (CPAP) in preterm neonates with respiratory distress reduces mortality by 66%. [11] Success rate of CPAP therapy is variable across the neonatal units.

Based on our study, we observed that there is no significant difference in efficacy of binasal prongs and nasal masks in terms of mean duration of hospital stay, mean duration of CPAP therapy, CPAP failure, overall incidence of nasal trauma, development of PDA, NEC, and ROP in premature neonates. Studies by Kieran et al., [12] Singh et al. [13] concluded that the overall rate of trauma, in the nasal prong group, was comparatively more than in the nasal mask group but was not

statistically significant. Our study also supports the same fact.

The types of injury were similar in the two groups, the sites of injury differed. In the nasal mask group, injuries occurred primarily at the base of the nasal septum at the junction between the nasal septum and the philtrum. This suggests that this is the area at which the mask exerts the greatest pressure, as prolonged pressure leads to impairment of tissue perfusion with resultant skin trauma. Injuries in the nasal prong group were confined primarily to the medial aspect of the nostrils on the nasal septum, indicating this to be the site of maximum pressure exerted by the prong. The lateral part of the nostrils may expand outwards when the prong are applied; the medial parts, being less mobile, are exposed to greater persistent pressure from the prong with resultant trauma. The mean birth weight in nasal mask and nasal prongs were 1180 ± 0.22 and 1182 ± 0.21 respectively while in Yong et al [14] mean birth weight were 1085(232) and 1105(228) mean weight in gm, less weight patient were in Yong et all study, in nasal mask and nasal prongs respectively.

Kumar G et al [15] found that failure of NCPAP was noticed in 11 (36.7%) patients in nasal prong group, while in nasal mask group NCPAP failure was noticed in 5(16.7%) patients. There was no statistically significant difference found in failure rate between the two groups ($P=0.080$). Median duration (IQR) in hrs on NCPAP support was 42.5hrs (25-55) in nasal prong group, while in nasal mask group median duration (IQR) was 47.25hrs (36-72) with a P value of 0.181. Goel S et al [16] also concluded that nasal continuous positive airway pressure failure occurred in 8 (13%) of Mask group and 14 (25%) of Prongs group but was statistically not significant (RR 0.53, 95% CI 0.24-1.17) ($P=0.15$). The rate of pulmonary interstitial emphysema was significantly less in the Mask group (4.9% vs. 17.5%; RR 0.28, 95% CI 0.08-0.96; $P=$

0.03). Incidence of moderate nasal trauma (6.5% vs 21%) ($P=0.03$) and overall nasal trauma (36% vs 58%) ($P=0.02$) were significantly lower in mask group than in the prongs group.

Our study also supports Chandrasekaran et al.¹⁵ who found severe nasal trauma to be more common (31% vs. 0%) among neonates in the nasal prong group. Kumar et al. [17] found that local nasal complications were detected in 33.3% in nasal prong group and 20% in nasal mask group ($P = 0.136$). [18]

Conclusion

Based on our study, we concluded that the use of binasal prongs and nasal masks as interface during CPAP therapy makes no difference in overall outcome of nasal trauma in the patient. Both were found equally effective and comparable to each other.

References

1. Singh J, Bhardwar V, Chirla D. To compare the efficacy and complication of nasal prongs vs nasal mask CPAP in Neonates. International Journal of Medical and Dental Sciences. 2017 Jan 1:1398-406.
2. JP G. Karotkin EH. Assisted Ventilation of the Neonate.
3. Cartlidge P. The epidermal barrier. Semin Neonatol. 2000; 5:273–80.
4. Kopelman AE, Holbert D. Use of oxygen cannulas in extremely low birthweight infants is associated with mucosal trauma and bleeding, and possibly with coagulase-negative staphylococcal sepsis. Journal of Perinatology. 2003 Mar;23(2):94-7.
5. DeRowe A, Landsberg R, Fishman G, Halperin D, Fliss D. Neonatal iatrogenic nasal obstruction. International journal of pediatric otorhinolaryngology. 2004 May 1;68 (5): 613-7.
6. Smith LP, Roy S. Treatment strategy for iatrogenic nasal vestibular stenosis in young children. International journal of pediatric otorhinolaryngology. 2006 Aug 1;70(8):1369-73.
7. Mathai SS, Raju U, Kanitkar M. Management of Respiratory Distress in the Newborn. Med J Armed Forces India. 2007 Jul; 63 (3): 269-72.
8. Polin RA, Sahni R. Newer experience with CPAP. Semin Neonatol. 2002 Oct;7(5):379-89.
9. Silverman WA, Andersen DH. A controlled clinical trial of effects of water mist on obstructive respiratory signs, death rate and necropsy findings among premature infants. Pediatrics. 1956 Jan;17(1):1-0.
10. Schmörlzer GM, Kumar M, Pichler G, Aziz K, O'Reilly M, Cheung PY. Non-invasive versus invasive respiratory support in preterm infants at birth: systematic review and meta-analysis. Bmj. 2013 Oct 17;347.
11. Thukral A, Sankar MJ, Chandrasekaran A, Agarwal R, Paul VK. Efficacy and safety of CPAP in low-and middle-income countries. Journal of perinatology. 2016 May; 36 (1):S21-8.
12. Kieran EA, Twomey AR, Molloy EJ, Murphy JF, O'Donnell CP. Randomized trial of prongs or mask for nasal continuous positive airway pressure in preterm infants. Pediatrics. 2012 Nov;130(5):e1170-6.
13. Singh J, Bhardwar V, Chirla D. To compare the efficacy and complication of nasal prongs vs nasal mask CPAP in Neonates. International Journal of Medical and Dental Sciences. 2017 Jan 1:1398-406.
14. Yong SC, Chen SJ, Boo NY. Incidence of nasal trauma associated with nasal prong versus nasal mask during continuous positive airway pressure treatment in very low birth weight infants: a randomised control study. Archives of Disease in Childhood-Fetal and Neonatal Edition. 2005 Nov 1;90(6): F480-3.
15. Kumar G, Copra M, Copra M. To study effectiveness of nasal prong and

- nasal mask in nasal continuous positive airway pressure in preterm neonates with respiratory distress. *Journal of Medical Science and Clinical Research*. 2017; 5:21409-15.
16. Goel S, Mondkar J, Panchal H, et al. Nasal Mask Versus Nasal Prongs for Delivering Nasal Continuous Positive Airway Pressure in Preterm Infants with Respiratory Distress: A Randomized Controlled Trial. *Indian Pediatr*. 2015 Dec;52(12):1035-40.
17. Chandrasekaran A, Sachdeva A, Sankar MJ, Agarwal R, Deorari AK, Paul VK. Nasal mask versus nasal prongs in the delivery of continuous positive airway pressure in preterm infants—An open label randomized controlled trial. *E-PAS*. 2014; 2936:5 12.
18. Srivastava D. M., Chowdhury D. S., & Vishal D. G. Giant Mucocele of Maxillary Sinus, Scarce Occurrence: Case Report. *Journal of Medical Research and Health Sciences*, 2022;5(2): 1774–1778.