Original Article

Hydrocolloid dressing in preventing nasal trauma secondary to nasal continuous positive airway pressure in preterm infants

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BACKGROUND: Continuous positive airway pressure (CPAP) with nasal devices (nCPAP) is widely used in the respiratory management of newborns. The present study aimed to compare the incidence of nasal trauma secondary to nasal continuous positive airway pressure (nCPAP) protected with or without hydrocolloid dressing in preterm infants.

METHODS: This prospective controlled study was performed in the neonatal intensive care unit (NICU) of the Children's Hospital of Hunan Province from March 1, 2010 to June 31, 2010. A total of 65 infants, 46 males and 19 females, were recruited in this study. Their average gestational age was 32.6 weeks (range 28–37 weeks). The infants were randomly divided into clinical trial group (group A, $n=33$) and control group (group B, $n=32$). Paraffin oil was smeared around the nostrils before inserting prongs in group B; the infants in group A were covered on the infant's nostrils surface with hydrocolloid dressing (hydrocolloid dressing, 1.8 mm thick, 90029T, 3M Company, Minnesota, USA) with a size of 2–3 cm cutting two holes adapted to the nose and nostrils. The nostrils of those infants were inspected daily during nCPAP support until they were weaned off nCPAP.

RESULTS: Nine infants (2 in group A and 7 in group B) developed nasal injury during nCPAP support. The Chi-square test revealed that there was a statistically significant difference ($P=0.01$) in the incidence of nasal injury between groups A and B.

CONCLUSION: The study demonstrated that hydrocolloid dressing significantly decreased the incidence and the severity of nasal injury.

KEY WORDS: Continuous positive airway pressure; Nasal injury; Hydrocolloid dressing; Preterm infants; Nasal prongs

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INTRODUCTION

Continuous positive airway pressure (CPAP) with nasal devices (nCPAP) is widely used in the respiratory management of newborns. nCPAP can improve oxygenation, maintain lung volume, lower upper airway resistance, reduce obstructive apnoea, and most importantly eliminate an ETT/ventilator and the associated risks.^[1,2] A nasal prong is the most commonly used for delivering CPAP because it is less invasive.^[3,4] However, nasal trauma is a well documented complication of noninvasive respiratory support.^[5,6] The

local pressure of nasal prongs to the nasal region is easy to cause nasal injury in the newborn due to the cutaneous vulnerability.^[6,7] Besides anatomical factors, such as end-vascularization of the columella and nostrils,^[8] Diblasi^[9] emphasized that fixation technique was also an important factor for selecting the proper hat and prongs. The lack of stabilization and, hence, excessive movement of the prongs could result in nasal injury, interface displacement, and loss of system pressure.^[9] In 2004, Buettiker et al^[7] compared three different systems of CPAP: the naso-pharyngeal tube

and two-prong systems in newborns, focusing on duration of CPAP, side effects and cost. They found that the nasopharyngeal tube was an easy, safe and economical CPAP system usable with every common ventilator. For very low birth weight newborns, a prong system may have advantages. In a randomized controlled clinical trial, Yong et al^[10] compared the incidence of nasal trauma associated with the use of prong or mask during nCPAP support in very low birthweight (<1 501 g) infants, and reported that there was no significant difference in the incidence of nasal trauma between the two groups ($P=0.5$). Logistic regression analysis showed that duration of nCPAP was the only significant risk factor associated with development of nasal injury, after birth weight, gestational age, and nasal device used had been controlled. The prolonged use of nCPAP resulted in more pressure, and if there is any area of pressure points exerted by the device, this would definitely cause trauma, no matter what kind of modes. However, injury to the columella during short binasal prongs CPAP had been reported as early as 3 days after CPAP.^[6] Yong et al^[10] reported an incidence of 35% for nasal trauma in the prongs group. Fischer et al^[11] found that 420 (42.5%) of 989 patients developed a nasal trauma. Gunlemez et al^[12] demonstrated that the silicon gel on the surface of the nostrils reduced the incidence of nasal injury in preterm infants.

In consideration of hydrocolloid dressing with advantages of an easy to use and cheap, based on the hypothesis that the use of hydrocolloid dressing on the surface of the nostrils could reduce the incidence or severity of nasal injury related to nCPAP used in preterm infants, we conducted a prospective study to investigate the role of hydrocolloid dressing in the prevention of nasal trauma, a common complication of nCPAP in preterm infants.

METHODS

This prospective controlled study was performed in the neonatal intensive care unit (NICU), a tertiary center for newborns, of the Children's Hospital of Hunan Province, China, between March 1, 2010 and June 31, 2010. The study protocol was approved by the ethical committee of the hospital. The Arabella ventilator driver system and infant nasal prongs were regularly used and driver was set up according to the manufacturer's instructions (Hamilton Medical, Bonaduz, Switzerland). The routine use of nCPAP was within hours after birth for the preterm infants affected by respiratory distress, pneumonia and asphyxia. Exclusion criteria were term gestation, nasal deformities, and pre-existing nasal lesions secondary to nasal intubation.

During the study period of three months, 186 preterm newborns were admitted to the neonatal intensive care unit. A total of 112 premature infants were ventilated with nCPAP. According to the inclusion and exclusion criteria, 65 infants were recruited with 46 males and 19 females in this study. The average gestational age was 32.6 weeks (range 28–37 weeks). The average birth weight was 1 800 g, but 15 neonates were 2 500 g. The underlying diseases included respiratory distress (38 infants), aspiration pneumonia (15 infants), asphyxia (7 infants), and unknown respiratory disease (5 infants).

In order to demonstrate the efficacy of hydrocolloid dressing in preventing nasal trauma due to nCPAP in neonates, the eligible infants were randomly divided into clinical trial group (group A, $n=33$) and control group (group B, $n=32$). Paraffin oil was smeared around the nostrils before inserting prongs in group B; the infants in group A were covered on the nostrils surface with hydrocolloid dressing (hydrocolloid dressing, 1.8 mm thick, 90029T, 3M Company, Minnesota, USA) with a size of 2–3 cm cutting two holes adapted to the nose and nostrils (Figure 1), followed by inserting nasal prongs into the infant's nasal cavity through the holes of hydrocolloid dressing during ventilation (Figure 2). It was held *in situ* with straps surrounding the head with an airtight seal to prevent the loss of positive pressure. The pressure of 4–6 cmH₂O was set up at the beginning of ventilation with nCPAP, and this should be regulated to maintain an oxygen saturation (SpO₂) of 85% up to 93% and to keep PaO₂ >50 mmHg until infants weaned from nCPAP.

The care of infants under nCPAP included visual inspection of the nose, prevention of the nCPAP displaced, and maintenance of the prone position of infants. The nose and nostrils of infants were visually inspected in the morning every day with the removal of the nCPAP and hydrocolloid dressing. During the study, once mild or moderate trauma was detected, the nasal prongs and masks were used alternatively and the devices were switched every 6 hours. In case of severe nasal injury, the nCPAP was terminated and treated by the oral intubation. At the same time, spraying agent (epidermal growth factor) and hirudoid cream were also applied alternatively for facilitating repair and regeneration of epidermal skin. The infants with nasal injury were followed up for at least three weeks for the evaluation of columella necrosis.

Nasal injuries were evaluated according to the classification proposed by Buettiker et al,^[11] who described the severity of nasal trauma secondary to nCPAP in neonates. Nasal injuries were classified as mild, moderate, and severe. A mild injury was defined as a reddening around the nasal ostium; a moderate injury was defined as bleeding either at

Figure 1. An illustrative case of hydrocolloid dressing with two holes on the nostrils surface of an infant.

Figure 2. Nasal prongs into the nasal cavity of the infant through the holes of hydrocolloid dressing.

Figure 3. Nasal trauma of mild: erythema around the nostrils with intact skin.

Figure 4. Columella scar and nasal deformity secondary to columella necrosis at 2 months of age in a premature male infant born at 27⁺ weeks of gestational age (birth weight=1 150 g).

the septum or nasal ostium; and a severe nasal injury was defined as necrosis either on the septum or nasal ostium.

Statistical analysis

The results were analyzed with the SPSS Version 11.0 for Windows (Prentice Hall Press Inc, New Jersey, America) and the Chi-square test was used for comparisons between groups A and B. A P value <0.05 was considered statistically significant.

RESULTS

The postnatal age at the study was 8 (1–18) days, the level of CPAP at the beginning of the study was 5 (4–6) cmH₂O, and the duration of CPAP was 9 (7.5–11.8) days. There were no obvious differences in the number of the patients and ventilation between the two groups, but they could not be identical in use of nasogastric feeding tubes, previous nasal intubation for surfactant administration, and nasal suctioning. The routine infant care was unchanged from previous practice by the nursing staff for the whole duration of the study. Nine infants developed nasal injury related to the use of nCPAP. The general incidence of nasal injury was 13.8%; the incidence of nasal injury was 6% ($n=2$) in group A and 21.8% ($n=7$) in group B (Table 1).

Table 1. Comparison of the occurrence of nasal injury in the two groups

Groups	Number of infants (n, %)	Mild & moderate injury (days)	Severe injury (days)	Total (n, %)
A	33 (50.8)	2 (3–5)	0	2 (6.0)
B	32 (49.2)	6 (mean 3, range 1–5)	1 (7)	7 (21.8)
P value	0.80	0.20	0.70	0.01

All these mild and moderate nasal injuries were seen at the base of the nasal septum and nostrils (Figure 3), at the junction between the philtrum and the base of the nasal septum. The time interval between the initiation of nCPAP and onset of injury was 3.2 days (range 1–7 days). Two patients had mild or moderate nasal trauma respectively in group A, but 6 infants had moderate and one had severe nasal trauma in group B. The patients with columella necrosis in group B had unsightly columella scar, which needed plastic surgery in future (Figure 4). All of the patients with nasal injury were followed up at last three weeks for the assessment of final outcomes. Healing at the time of nCPAP weaning was observed in all infants with mild and moderate nasal trauma except an infant with columella nasi necrosis. The mean time to healing in all the infants was 3.5 days (range 2.5–7 days), but the infant with columella nasi necrosis needed 3 weeks for healing.

DISCUSSION

Since Gregory et al^[1] first reported the efficacy of continuous positive airway pressure as the treatment of respiratory distress syndrome in 1971, continuous positive airway pressure is a well-established noninvasive pattern of respiratory assistance in all weight groups of newborns.^[2-4] Kattwinkel et al^[13] first described the initial experience using short bi-nasal prongs to deliver CPAP in a small case series of infants supported using nasal prongs and a T-piece CPAP system, similar to that reported by Gregory et al. That 82% never required any other form of support, including mechanical ventilation. Although various devices had been developed to deliver continuous positive airway pressure such as nasopharyngeal tube, different prong systems and mask CPAP, the bi-nasal prongs have been most widely used in the respiratory management of neonates.^[4] Nasal injury was the common complication of continuous positive airway pressure. Robertson et al^[6] found that the flow driver of continuous positive airway pressure could result in snubbing of the nose, flaring of the nostrils, and necrosis of the columella nasi, and that the total incidence of nasal trauma with nasal prong was 20% in a group of VLBW infants. Yong et al^[10] had carried out the study to compare the incidence of nasal trauma caused by nasal mask and by nasal prongs during nCPAP treatment using the infant flow driver system, and they found that the nasal injury rates were 35% (17/48) of the infants for the prongs and 29% (12/41) for the mask, in which its total incidence was 32.5%, but there was no significant difference in the incidence of nasal trauma between the two groups. Fischer et al^[11] reported that 42.5% (420/989) of the infants developed a nasal trauma. Among the 420 infants, 371 (88.3%) had a stage I nasal trauma, 46 (11%) had a stage II trauma, and 3 (0.7%) had a stage III trauma according to the National Pressure Ulcer Advisory Panel. The frequency and severity of nasal trauma increased in infants with a lower gestational age, a lower birth weight, a longer duration of nCPAP, and a longer NICU stay. Studies^[3,4,7] compared the advantages of one or the other systems focusing on the incidence of nasal trauma and time on CPAP. In this study, we focused on potential protective effects of the hydrocolloid dressing on nasal tissue during nCPAP in preterm infants. Compared the incidence of nasal injuries associated with the use of prongs reported in the literature, we found that the use of hydrocolloid dressing for preterm infants with nCPAP decreased the incidence of nasal trauma because of its favorable sealing and reduction of excessive pressure against the nostrils and nasal septum, and the short interval (3.2 days, range

1–7 days) between the initiation of nCPAP and the onset of injury was ascertained. In this short-term study, hydrocolloid dressing appeared to be as effective as silicon gel in preventing nasal trauma in preterm infants ascribed to nCPAP.^[12] Moreover, we presumed that the low overall incidence of nasal injury (13.8%) might be underestimated because of relatively longer gestational age and larger birth weight of infants in this study.

Mechanical ventilation administered by nasal devices (nCPAP) is an effective means of support for RDS and asphyxia in infants. It has been regarded as a non-invasive mode of ventilation and also has many advantages, such as improving oxygenation, maintaining lung volume, lowering upper airway resistance, and reducing obstructive apnoea.^[14] But there are still many problems with the use of nCPAP, like nasal damage and septum breakdown of premature neonates secondary to nCPAP.^[4,11] Therefore, how to prevent nasal trauma becomes the research topic among the neonatal nursing care in NICU. The etiology of nasal injury secondary to nCPAP is that the increased pressure around the nostrils decreases the circulation of blood flow which impairs tissue perfusion, and subsequently causes ischemic lesions.^[8] Thus relieving the pressure is the key factor for the prevention of nasal trauma.^[11] McCoskey^[15] reported the important role of positioning the neonate in preventing nasal injury with nCPAP application, and also pointed out concrete proposals by positioning the neonate in prone with the neonate's hand tucked under the chin to keep the mouth closed and less altering of the prongs or mask. Gunlemez^[12] investigated the efficacy of the silicon gel application on the nostrils in prevention of nasal injury in preterm infants ventilated with nCPAP. His results indicated that 4.3% (4/92) of neonates with the silicon gel sheeting on the surface of the nostrils developed nasal injury, but 14.9% (13/87) of the patients without using silicon gel had nasal injury. Although the incidence of nasal injury with hydrocolloid dressing was comparable to that reported by Gunlemez, the infants in our study had relatively longer gestational age and larger birth weight than those in Gunlemez's study. However, both studies demonstrated that silicon gel or hydrocolloid dressing could prevent nasal trauma of preterm infants secondary to nCPAP.

With respect to the management of nasal injury due to nasal CPAP, the optimal recommendation is yet to be established. Yong et al^[10] suggested that nCPAP should be terminated as soon as possible. If there was redness, excoriation, or crusting, a protective dressing (Duoderm) can be used to prevent worsening. Fischer et

al^[11] reported that nasal trauma is a frequent complication of nCPAP, especially in preterm neonates, but long-term cosmetic sequelae are very rare. Specific measures like hydrocolloid film and ointment (dexpanthenolum) can be used in patients with nasal trauma. Carlisle et al^[16] described a novel method of oral CPAP delivery in an extremely premature infant with severe nasal septum erosion. The distal end of a cut down endotracheal tube was passed through a small hole made in the teatment of a dummy (infant pacifier) and sutured in place. The dummy was secured in the infant's mouth and CPAP was delivered to the pharynx. The device was well tolerated and the infant was successfully managed using this technique for 48 days, avoiding endotracheal intubation and ventilation. In our NICU, mild and moderate nasal injuries were treated by spraying an agent (epidermal growth factor) and hirudoid cream alternatively in order to promote repairment and regeneration of epidermal skin, but nCPAP continued. The severe nasal trauma occurred in one male infant who was CPAP dependent, and treated by oral intubation.

A major limitation of our study was the use of paraffin oil in group B. In addition, paraffin oil has the possibility to cause the breakdown of natal skin in infants. The relatively longer gestational age and larger birth weight of infants in this study may be another limitation, because the frequency and severity of nasal trauma increased along with lower gestational age and lower birth weight.

In conclusion, hydrocolloid dressing is a soft, flexible and cheap material, and is easy and safe to use. Preliminary results demonstrated that the incidence and severity of nasal injury such as necrosis of full thickness of skin surrounding the nostrils and columella necrosis significantly decreased. Further study is needed to investigate the efficacy in preterm infants weighing <1 500 g. Meanwhile the short interval (mean 3.2 days) between the initiation of nCPAP and the onset of injury was found, and this suggested that it is necessary to carefully and frequently inspect the nose and nostrils at the first day of application of nCPAP in preterm infants.

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Conflicts of interest: The authors have no competing interests relevant to the present study.

Contributors: Xie LH proposed the study, analyzed the data and wrote the first draft. All authors contributed to the design and interpretation of the study and to further drafts.

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