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Impact of Positioning on Neonatal Respiratory Distress Syndrome

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Abstract

Neonatal respiratory distress syndrome, or RDS, is a common cause of respiratory distress in a newborn, presenting within hours after birth, most often immediately after delivery. RDS primarily affects preterm neonates, and infrequently, term infants. The incidence of RDS is inversely proportional to the gestational age of the infant, with more severe disease in the smaller and more premature neonates. While treatment modalities, including antenatal corticosteroids, surfactants, and advanced respiratory care of the neonate, have improved the outcomes for patients affected by RDS, it continues to be a leading cause of morbidity and mortality in the preterm infant. Because of the association of prone positioning with sudden infant death syndrome (SIDS) it is recommended that young infants be placed on their backs (supine). However, the supine position may be a non-invasive way of increasing oxygenation in participants with acute respiratory distress. Because of substantial differences in respiratory mechanics between adults and children and the risk of SIDS in young infants, a specific review of positioning for infants and young children with acute respiratory distress is warranted.

Keywords: Positioning, Neonates, Respiratory Distress Syndrome.

Mini-review article **Corresponding Author, Oemara4q@hotmail.com*

1. Introduction

Positioning neonates for therapeutic effect has long been proposed as a mechanism for increasing oxygenation in participants with acute respiratory distress. Body positioning is a non-invasive intervention which may augment oxygenation while avoiding some of the associated risks. In children, and particularly infants, the risk of injury from oxygen toxicity and mechanical ventilation is greater than in adults as the lungs are going through a period of high growth and development. Positioning may reduce the need for such interventions, or at least reduce the length of time they are required, thereby reducing the associated risk of longer-term lung damage [1]. In addition, the use of the prone position which is a relatively simple and inexpensive therapy is again becoming popular for neonates with acute respiratory distress syndrome in neonatal intensive care units. However, the use of prone positioning for infants and young children is controversial as it is linked to sudden infant death syndrome (SIDS). Other positions, including lateral (side-lying) positioning have also been proposed to assist in maintaining optimal ventilation and oxygenation during episodes of respiratory distress [2].

Structural differences of the respiratory system are evident in infants and young children when compared with adults. Alveolar and bronchiolar growth continues after birth with the alveolar surface area increasing by a factor of 20 as a person reaches adulthood. Supporting airway cartilage, small airway muscles and the intercostal muscles are not fully developed until school age and the chest wall of the infant and young child is much more compliant than the chest wall of an adult. These differences may lead to a relative increase in the infant's or children respiratory effort during an episode of respiratory distress, which may further compromise the ability to maintain effective ventilation [3]. Body position enhances oxygen transport by the operational effect of gravity on cardiopulmonary and cardiovascular function. Body positioning is an important part of respiratory care. Frequently changing position might not appear an effective technique. However, this easily implemented strategy usually prevents recourse to longer overwhelming or exhausting techniques. Positioning improves gas exchange and reduces pathology; several patients with respiration difficulties mechanically adopt a posture that facilitates their respiration [4].

Prone positioning has been actively studied in recent years and is considered an effective therapy for severe acute respiratory distress syndrome (ARDS) in adults as it improves oxygenation through several mechanisms [5-6]. First, there is a more homogeneous inflation distribution resulting in a steadier gas/tissue ratio, which allows a more evenly distributed transpulmonary pressure. Therefore, the energy provided by mechanical ventilation will also be more uniformly distributed, thus reducing the risk of ventilation-induced lung injury. Second, there is a decrement in chest

wall compliance compared to the supine position, which facilitates a more homogeneous ventilation, particularly in ventral and para-diaphragmatic zones. Third, because of the lung tissue shape and distribution, pronation can produce a net positive difference between the recruitment and the de-recruitment of the dorsal and ventral lung zones, respectively, which results in a lower shunt fraction, as the lung perfusion is unchanged; more in general this mechanism may improve ventilation/ perfusion matching [7].

Furthermore, once useful positions are adopted, gravitational, hydrostatic and compressional forces engaged on the heart, chest wall, lungs, vascular system, and blood volume, as well as the diaphragm, eventually combine to improve oxygen transport. Frequent changes in position and rejection of spending long periods in any single position can minimize the danger of decreasing returns, which are inevitable. Modified physical states yield to modified physiological effects, such as cardiovascular and respiratory function, this arising from the effect of gravity on the bloodstream and its circulation within the blood vessels and their associated systems. Pneumonic and other changes within the diaphragm occur primarily because of abdominal visceral pressure, and among the factors prompting the respiratory effects of varied positions of the body [8]. Also, it worth mentioning that ventilation in dorsal position resulted in large sternum diaphragmatic mobility in the sternum side, most VT in the sternum side, and few blood flows. Several blood flows in the dorsal side and few air flows lead to increased shunt and more unreasonable V/Q ratio.

Ventilation in prone position resulted in gradient decrease in the gravity distribution of intrapleural pressure, which was even from upside to downside. Transpulmonary pressure was also even so that the previously collapsed alveoli in dorsal lung could re-dilate. The ventilation throughout the lung was even, with matched V/Q and reduced shunt; as a result, the oxygenation was improved. The improvement in the respiratory mechanics may be related to the thoracic stability in breath and the motion amplitude of the diaphragm. In dorsal position, the heart oppressed the lung tissue directly in the dorsal side of chest wall, while in the prone position, the heart weight oppressed the sternum, thus helped relieve the oppression of lung tissue in the dorsal side of the sternum by the heart, and improved ventilation in local lung tissue and blood perfusion [9]. The best technique of positioning for neonates is unknown. The position is very important in ventilation and oxygenation of tissues. Though the prone position as one of those recommended shows a helpful impact on the development of premature infants, very little research has been done. Neonatal respiratory failure is a major cause of neonatal death.

Mechanical ventilation has been widely applied as the most common and effective approach, with dorsal position as the regular position. Recently, increasing attention has been paid to prone position ventilation for lung protective ventilation strategy. Different positions of mechanical ventilation to treat neonatal respiratory failure, as an alternate strategy to prone position and dorsal position. This strategy may possibly improve oxygenation, reduce complications with satisfactory results in children [10]. The bone structure of child is mainly comprised of cartilage, the articular ligament is relatively loose, the muscle is relatively weak, and the bone is easy to bend and deform. Thus, keeping one pose for a long period may result in malformation. Mechanical ventilation with different positions and patient turn-back are beneficial for backslapping and suctioning to promote sputum discharge, maintain unobstructed respiratory tract, keep comfortable position, and reduce bedsores or malformation. Therefore, alternating prone position with dorsal position is necessary for children. The body weight of neonate is small, the turn-back is easier for neonate than adult, and the cost is less. Sleeping in prone position is a risk factor of Sudden Infant Death Syndrome; therefore, the ventilation in prone position requires close monitoring [10].

Although prone positioning is obviously easier to perform in neonates than in adults, scanty data are available about its effects on critically ill neonates: ventilation distribution has been studied only for short periods, in small groups of babies and without the latest monitoring techniques, whereas haemodynamics had never been investigated [7]. It should be noted that a universal structured well-examined protocol for proning is absent, despite the few studies that suggest benefits from it in neonates with RDS, no studies had been stated on specific firm recommendations regarding timing, duration or short term complications of prone position in neonates with RDS. In study underwent by Wood et al. [11], PaO2, OI, VT, and Cdy at 8 and 16 h in alternate position groups were higher than those in dorsal position group, and the differences were statistically significant. This indicated that the oxygenation and respiratory mechanics were significantly improved in alternate position group than those in dorsal position group, and the improvement was enhanced over time as was reported by Rivas-Fernandez et al. [12] Currently recognized view about ventilation in dorsal position is to improve the ratio of ventilation/blood flow (V/Q), and reduce pulmonary shunt (intrathoracic pressure gradually decreases along the direction of gravity from upside to downside, or even becomes positive pressure).

In the case of respiratory failure, the positive intrathoracic pressure in most prolapse area was so large that no adequate negative pressure was produced at the end of inhalation, leading to alveolar collapse in the prolapse area. Another study suggested that prone position can improve oxygenation and save time for the treatment. The survival of severe ARDS patients could be increased significantly in prone position. Recently, NEJM online issued a controlled study report written by Guérin and colleagues [6] in France Croix-Rousse Hospital ICU, suggesting that the ventilation in prone position for 12 h daily could significantly decrease the mortality in severe ARDS patients ($PaO_2/FiO_2<150$ mm Hg, $FiO_2 \geq 0.5$, PEEP $\geq$ 5 cm H_2O, for 12–24 h). This report also indicated that the severe ARDS patients should receive ventilation in prone position as soon as possible. Appropriate extended duration of the ventilation in prone position could improve the prognosis. Currently, no uniform standard is available for the duration of neonatal ventilation in prone position and the optimal frequency of position change; therefore, large sample study is still necessary [1]. Balaguer et al. [13] in a systematic review study about the effect of positioning on amount of SPO2, showed that in several studies SPO2 in the prone position increased between 1.18 to 4.36% during the intervention (prone position).

The difference between SPO2 in minutes 0 and 120 was 1.2% in prone position, which was in accordance with the above studies. Premature infants, who were oxygen dependent and prepare for discharge from neonatal unit, had

higher SPO2 and FRC in prone position than in supine position. Preterm infants 1 and 6 hours after weaning from mechanical ventilation had a higher PaO2 in prone position compared with supine position. In prone position the mean of SPO2 was significantly higher than in supine position. These findings as well goes hand in hand with the results of a study done by [14]. One more study suggested that positioning infants on the prone position decreased their activities and led to better oxygenation and decreased the number of SPO2 attacks drops compared to supine position. In addition, prone position increases the duration of active sleep and decreases crying in infants. The number of attacks of apnea and bradycardia had no difference in the supine and prone positions in preterm infants. Prone position improves oxygenation in infants with respiratory distress, who were receiving oxygen through a hood. Moreover, Placing neonates in prone position for duration of 120 minutes increased the mean of SPO2 [10]. Regarding complications, no complication occurred during the short term duration that the infant was positioned in prone position.

The longer the infants remained in this position, the more complications likely could be observed. According to our knowledge, no study has ever been conducted in Iran on the complications of prone positioning for a long time, but in a study by Curley, some of the infants, who were in prone position for a long time, suffered from bed sores [1]. Therefore, this study was carried out to compare the effect of the prone-and supine position on respiratory rate, pulse rate and oxygen saturation on newborns with-acute respiratory distress syndrome. Improving nursing intervention for neonates with respiratory distress is very important because of the costly medical care, high morbidity and mortality rates associated with the disease. It also reduces length of hospital stay, especially in settings with limited facilities for intensive care, including the availability of mechanical ventilation and cost of oxygen therapy [15]. All neonates were stabilized after needful resuscitation, then nursed in supine position for 3 hours before recording their Oxygen saturation and respiratory rate. Then patient was kept in prone position for 6 hours and oxygen saturation and respiratory rate was measured every 2 hours. Oxygen was administered through head box or nasal prongs. Oxygen saturation was monitored with Oxypleth Pulse Oximeter [15].

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