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A non-invasive technique for evaluation of respiratory efforts in preterm infants during feeding

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Abstract The aim of this study was to develop a minimally invasive technique to evaluate respiratory patterns in preterm infants during feeding.
Methodology: Respiratory flow was obtained with a pneumotachograph coupled initially to a mask and then to a prong, both with a differential pressure transducer. Respiratory plethysmography was used to measure thoraco-abdominal movements. This recording allowed calibration of the preterm infant's tidal volume prior to feeding experiments. Electromyography was used to monitor oral muscle movements through electrodes attached to the buccinator, masseter and mentalis muscles. A pulse oximeter and cardiac monitor were used for continuous monitoring of vital signs. The infants were positioned vertically in a semi-sitting position in an infant seat.
Results: The methodology developed here was considered effective in achieving the proposed aims. With the integration of all these systems, it was possible to evaluate the respiratory patterns of preterm infants during cup feeding.
Conclusion: This method allows the analysis of respiratory flow, volume, and O_2 saturation during feeding and identification of the moment in which a change in breathing occurs (i.e., pausing or feeding). This method is minimally invasive, providing the preterm infant with an environment that is as close to normal as possible.

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Introduction

Due to advances in technology and medical science, the survival of preterm infants has become increasingly frequent. Preterm infants face a number of special challenges, and significant evidence-based research approaches have aimed to improve treatment of these patients.

An infant's first need at birth is to breathe, and the second is to eat (Paula et al., 2002); both of these are a challenge for preterm infants. In order to feed safely and effectively, the infant must be able to coordinate sucking, swallowing and breathing, a skill that tends to improve with gestational age (Sakalidis et al., 2013). Impairment of any one of these functions can put the infant at risk for aspiration, pneumonia, oxygen desaturation, apnea, and bradycardia (Lau and Hurst, 1999). Thus, understanding how preterm infants breathe during feeding represents an important step toward further improving their health and development.

Few methods for evaluating the behavior of the respiratory system during neonatal feeding have been described in the literature, and most of the existing methods are invasive (Daniels et al., 1986; Gewolb et al., 2001; Koenig et al., 1990) and these have been described in a review by Tarrant et al. (1997). Invasive techniques can alter the respiratory patterns and may cause discomfort. Thus, the development of a non-invasive technique for evaluating the respiratory effort in preterm infants during feeding is important.

The techniques used to evaluate breathing coordination during feeding that have been described in the literature were used during bottle feeding. However due to the implementation of cup feeding in neonatal units it was necessary to adequately assess this technique. A Cochrane review of feeding methods in preterm infants (Flint et al., 2007) highlighted the limited number of scientific articles on this topic that exhibited sufficient methodological rigor for inclusion. It is thus necessary to establish efficient methodologies for studies of feeding in preterm infants.

The aim of this study was to assess the feasibility of the use of a non-invasive technique to evaluate breathing coordination during cup feeding in preterm infants.

Methodology

The study was approved by the Institutional Review Board of the Instituto Nacional de Saude da Mulher, da Criança e do Adolescente Fernandes Figueira in Brazil (study protocol 0059.0.008.000-06). It was conducted in the lung function laboratory, which is staffed and equipped to conduct detailed investigations of thoraco-abdominal movements and respiratory flow patterns.

Infants born at Instituto Nacional de Saude da Mulher, da Criança e do Adolescente Fernandes Figueira from August 2006 to March 2007 were included. The inclusion criteria were: birth weight less than 1500 g, gestational age from 26 to 32 complete weeks, absence of congenital anomalies, severe perinatal asphyxia (as defined by 5-min Apgar score <5 or convulsions in the first 24 h) and bronchopulmonary dysplasia. Infants with sepsis or/and intraventricular hemorrhage grade III or IV (documented by ultrasound) were excluded. The eligible infants were recruited when they started oral feeding, were at least 32 weeks gestational age, and were clinically stable. They had been evaluated by the speech therapist as being ready to start oral feeding.

Informed consent was obtained from the parents or guardians of the patient prior to their inclusion.

During the development of a non-invasive technique, we used a resuscitation-type mask, a nasal prong (in different sizes) coupled to a pneumotachograph (Fleisch 00) and a differential pressure transducer (Validyne DP45). To measure respiratory flow during feeding we used the respiratory inductance plethysmography system (RIP) (Respitrace) that consisted of a non-invasive monitor with two transduction bands wrapped circumferentially around the chest wall and abdomen (at the level of the axillae and umbilicus, respectively).

To record the movements of the oral muscles involved in feeding, electrodes for electromyography were attached to the buccinator and masseter muscles (bilaterally) and the mentalis muscle. The electrodes were then coupled to the electromyograph (Lab Linc V, Coulbourn Instruments). Electromyography was used to record when the infant was being fed and during pauses, in order to determine the moment in which changes in breathing occurred.

Safety during feeding is an aspect addressed in the literature and generally evaluated by oxygen saturation and heart rate (Marinelli et al., 2001; Sakalidis et al., 2012, 2013), thus, vital signs were monitored during feeding using a pulse oximeter and cardiac monitor (Massimo SET).

Thoraco-abdominal movements, electromyography, respiratory flow, and oxygen saturation were recorded simultaneously and saved to a computer for later analysis. PCLAB (Data Translations) software was used for analog signal