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Effect of passive mobilization on the cardiorespiratory parameters of premature neonates

Efeito da mobilização passiva nos parâmetros cardiorrespiratórios de recém-nascidos prematuros

Efecto de la movilización pasiva sobre los parámetros cardiorrespiratorios de recién nacidos prematuros

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Abstract
*Objectives***:** To evaluate the effect of passive mobilization on the cardiorespiratory parameters of preterm neonates in a neonatal intensive care unit (NICU). *Methods***:** Preoperative intervention study evaluating 27 preterm infants admitted to NICU in a teaching hospital in the city of Santa Cruz do Sul – RS, from September 2016 to May 2017. The intervention consisted of 15 minutes of passive mobilization with flexion and extension of upper and lower limbs, and dissociation of pelvic girdle. Heart rate (HR), respiratory rate (RR) and peripheral oxygen saturation (SpO_2) were assessed before and after each intervention, and pain intensity was evaluated through the Neonatal Infant Pain Scale (NIPS) and respiratory distress through the Silverman Andersen respiratory severity score (SAS). *Results***:** Preterm neonates (n= 27; males, n= 16) with a gestational age of 30.3 ± 2.8 weeks, corrected gestational age of 34.5±1.6 weeks, weight of 1.62±0.4 kg and height of 40 (39-43) cm. There was a reduction in HR (p= 0.006) and an increase in SpO_2 ($p<0.001$) without pain, respiratory discomfort and change in RR after passive mobilization. *Conclusion***:** Passive mobilization significantly reduced heart rate, increased peripheral oxygenation and did not cause respiratory pain or discomfort in the evaluated neonates.
Keywords: Premature birth; Physiotherapy; Intensive care units; Infant, premature; Motor activity.

Resumo
*Objetivo***:** Avaliar o efeito da mobilização passiva nos parâmetros cardiorrespiratórios de recém-nascidos pré-termo em unidade de terapia intensiva neonatal (UTIN). *Métodos***:** Estudo de intervenção pré-operatória avaliando 27

prematuros internados em UTIN em um hospital universitário da cidade de Santa Cruz do Sul – RS, no período de setembro de 2016 a maio de 2017. A intervenção consistiu em 15 minutos de mobilização passiva com flexão e extensão de membros superiores e superiores. membros inferiores e dissociação da cintura pélvica. A frequência cardíaca (FC), a frequência respiratória (FR) e a saturação periférica de oxigênio (SpO_2) foram avaliadas antes e após cada intervenção, e a intensidade da dor foi avaliada por meio da Neonatal Infant Pain Scale (NIPS) e o desconforto respiratório pelo escore de gravidade respiratória Silverman Andersen (SAS). *Resultados*: Recém-nascidos prematuros (n= 27; sexo masculino, n= 16) com idade gestacional de 30,3 ± 2,8 semanas, idade gestacional corrigida de 34,5 ± 1,6 semanas, peso de 1,62 ± 0,4 kg e altura de 40 (39-43) cm. Houve redução da FC (p= 0,006) e aumento da SpO_2 (p<0,001) sem dor, desconforto respiratório e alteração da FR após mobilização passiva. *Conclusão*: A mobilização passiva reduziu significativamente a frequência cardíaca, aumentou a oxigenação periférica e não causou dor ou desconforto respiratório nos neonatos avaliados.
Palavras-chave: Nascimento prematuro; Fisioterapia; Unidades de terapia intensiva; Recém-nascido prematuro; Atividade motora.

Resumen
Objetivo: Evaluar el efecto de la movilización pasiva sobre los parámetros cardiorrespiratorios de recién nacidos prematuros en una unidad de cuidados intensivos neonatales (UCIN). *Métodos*: Estudio de intervención preoperatoria que evaluó 27 prematuros internados en la UCIN de un hospital escuela de la ciudad de Santa Cruz do Sul – RS, de septiembre de 2016 a mayo de 2017. La intervención consistió en 15 minutos de movilización pasiva con flexión y extensión de los músculos superiores e inferiores. miembros inferiores y disociación de la cintura pélvica. Se evaluó la frecuencia cardíaca (FC), la frecuencia respiratoria (FR) y la saturación periférica de oxígeno (SpO_2) antes y después de cada intervención, y se evaluó la intensidad del dolor a través de la Escala de Dolor Infantil Neonatal (NIPS) y la dificultad respiratoria a través de la puntuación de gravedad respiratoria de Silverman Andersen (SAS). *Resultados*: Recién nacidos prematuros (n= 27; varones, n= 16) con edad gestacional de 30,3 ± 2,8 semanas, edad gestacional corregida de 34,5 ± 1,6 semanas, peso de 1,62 ± 0,4 kg y talla de 40 (39-43) cm. Hubo reducción de la FC (p= 0,006) y aumento de la SpO_2 (p<0,001) sin dolor, molestias respiratorias y alteración de la FR después de la movilización pasiva. *Conclusión*: La movilización pasiva redujo significativamente la frecuencia cardíaca, aumentó la oxigenación periférica y no provocó dolor ni molestias respiratorias en los neonatos evaluados.
Palabras clave: Nacimiento prematuro; Fisioterapia; Unidades de cuidados intensivos; Recien nacido prematuro; Actividad motriz.

1. Introduction

Prematurity represents a challenge because it is a global public health problem with high morbidity and mortality. Brazil ranks 10th among the countries with the highest number of preterm live births and 16th in deaths from complications of prematurity (Ross et al, 2017). Premature birth is considered an important health indicator as it is the most frequent cause of neonatal death and implies in higher long-term morbidity rates in children who survive (Silveira et al, 2018; Frey & Klebanoff, 2016). Preterm birth has a multifactorial etiology such as social, psychological, behavioral, socioeconomic and cultural (Voguel et al, 2018).

As a consequence of prematurity, the newborn (NB) can present neurological, cardiorespiratory and motor disorders that can be perpetuated into adulthood (Voguel et al, 2018; Ream & Lehwald, 2018). In addition, the prolonged length of stay in the neonatal intensive care unit (NICU) can cause even greater impacts due to the NB's exposure to stressful factors such as intense light, noise, clinical procedures and little social interaction, which affects their global development and causes cardiorespiratory changes, which may cause an increase in heart rate (HR), respiratory rate (RR) and drop in peripheral oxygen saturation (SpO_2) (Cardoso et al, 2015; Jordão et al, 2016).

Physical therapy in preterm infants attenuates developmental deficits through early stimulation, reduces stress and facilitates global perception (Sharma et al, 2018), resulting in satisfactory responses regarding the prevention and treatment of complications arising from prematurity through a therapeutic plan that includes bronchial clearance, therapeutic positioning and joint mobilization (Theis et al, 2016). The passive mobilization of NB that is premature stimulates bone mineralization, muscle tone and trophism, stabilizes the motor pattern, prevents deformities and/or contractures, reduces pain, enhances neuropsychomotor development and improves motor and behavioral response (Sharma et al, 2020), however, may present some risks such as long bone fractures cardiorespiratory and behavioral disorders (Schulzke et al, 2014).

This is a relevant topic as with the survival of extreme preterm infants, the sequelae related to neuropsychomotor development still generate a great impact on the family and on the health services that assist the NB after hospital discharge. Thus, the present study aimed to evaluate the effects of passive mobilization on cardiorespiratory parameters, pain and respiratory distress in premature neonates in a NICU.

2. Methodology

Quantitative pre-experimental study that accessed 27 preterm neonates from 25 to 35 weeks of gestation, in a convenience sample from September 2016 to May 2017, in the NICU of a teaching hospital in the city of Santa Cruz do Sul, RS. The research was approved by the Research Ethics Committee of the University of Santa Cruz do Sul (number 1640,722) and those responsible for the newborns signed the Informed Consent Form. Preterm NB with less than 37 weeks of gestation and of both genders, clinically stable, born by cesarean or vaginal delivery and with a medical prescription to perform motor physiotherapy were included. Those who were under mechanical ventilation, with infectious-contagious diseases or with orthopedic or clinical limitations that contraindicated passive mobilization were excluded.

Clinical data, length, body weight, 1st and 5th minute Apgar, gestational and delivery characteristics were evaluated based on data obtained from the patient's medical record. Subsequently, cardiorespiratory variables (HR, RR and SpO_2), the presence of pain and respiratory discomfort were measured before and immediately after the performance of passive mobilization.

Cardiorespiratory parameters, presence of pain and respiratory distress

The HR and SpO_2 variables were obtained using a Dixtal monitor (model DX2023, Brazil) with the NB in the supine position (SP). RR was measured by measuring the number of breaths in a 1-minute period. The presence of pain was assessed using the Neonatal Infant Pain Scale (NIPS), which is a useful and widely applicable tool for health professionals who care for preterm NB exposed to painful stimuli. This scale assesses five behavioral factors (facial expression, crying, movements of the upper and lower limbs and alertness) and a physiological factor (respiratory pattern) in which each factor contains two items, scored as 0 or 1, except for the “cry”, which has three items scored from 0 to 2. The total score ranges from 0 to 7, with a score greater than 3, indicative of pain (Beltrami et al, 2017).

The presence of respiratory distress was assessed using the Silverman Andersen respiratory severity score SAS, which is a useful clinical method to assess the degree of respiratory distress and determine the severity of pulmonary impairment. This instrument assesses the presence of five aspects of respiratory distress: expiratory moaning, flapping of the nose, intercostal retraction, sternal retraction and paradoxical breathing and its score ranges from 0 to 10 being 0, indicator of absence of respiratory distress, 1 to 5 moderate discomfort and 6 to 10, severe discomfort (Roussenq et al, 2013).

It is noteworthy that the measurements of anthropometric variables, the presence of pain and respiratory discomfort were performed immediately before and after passive mobilization with three measurements of HR, RR and SpO_2 with subsequent arithmetic mean.

Passive mobilization

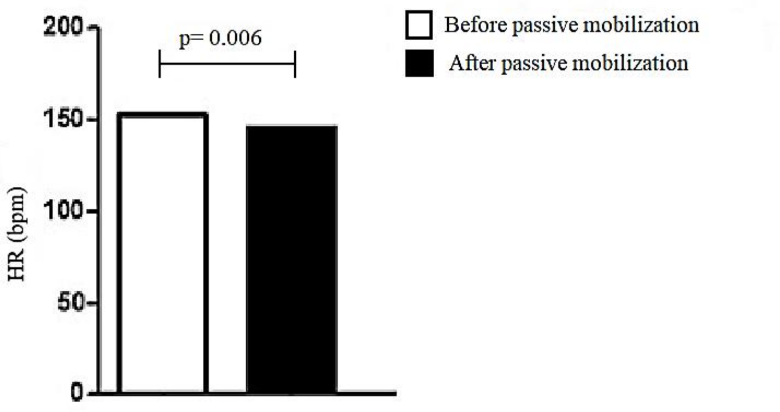
The NB were submitted up to 15 minutes of passive mobilization in order to relax the muscles, stimulate movement and tactile sensitivity, with a minimum mobilization time of 10 minutes. Fifteen repetitions of the alternating reaching movement of the arms (alternating movements of flexion and extension of the upper limbs), alternating “kicks” (movements of flexion and extension of the lower limbs) and dissociation of pelvic girdle were performed with the neonate in SP in the incubator, according to the protocol adapted from Moreno, Fernandes and Guerra (Moreno et al, 2011).

Table 1. Clinical characteristics of the evaluated neonates.

Variables	**Sample (n=27)**
Weight (kg)	1.62±0.4
Length (cm)	40 (39 – 43)
Apgar 1st minute	8 (7 –9)
Apgar 5ST minute	9 (8 – 9)
Maternal age (years)	29 (22 – 32)
Sex male, n (%)	16 (59.3)
Vaginal	4 (14.8)
Cesarean	23 (85.2)
Diagnosis, n (%)	
Apnea of prematurity	1 (3.7)
Gastroschisis	1 (3.7)
Early-onset neonatal sepsis	1 (3.7)
Transient tachypnea of the newborn	1 (3.7)
RDS	13 (48.1)
Prematurity	10 (37.0)

RDS: Respiratory distress syndrome. Data expressed as frequency, mean±standard deviation and median and interquartile range. Source: Own authorship.

Figure 1. Heart rate before and after passive mobilization. Student t test (p≤0.05).



HR: Heart rate. bpm: beats per minute.
Source: Own authorship.

Adverse events such as increased HR or HR<100 beats per minute for 12 seconds, desaturation for more than 30 seconds and less than 88%, hypertension or hypotension, tachypnea or apnea, respiratory discomfort (use of accessory muscles, wing beat of the nose, intercostal and subdiaphragmatic pull, furcula and xyphoid retraction, paradoxical breathing and/or cyanosis) observed during the application of tactile and kinesthetic stimulation were considered clinical signs for the interruption of the stimulation (Moreno et al, 2011).

Statistical analysis

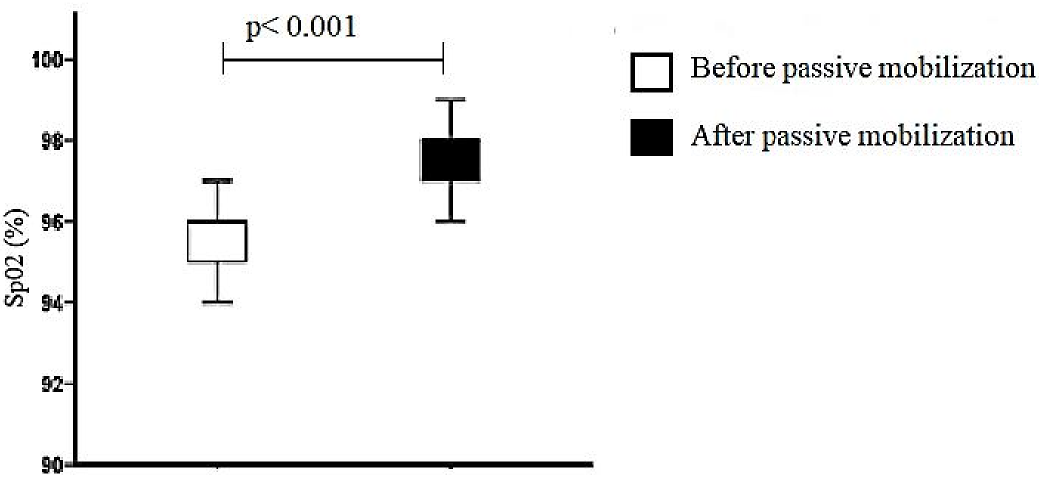
For data analysis, the Statistical Package for Social Sciences program (SPSS 23.0, IBM, Armonk, NY, USA) was used. Normality was assessed using the Shapiro-Wilk test and described as frequency, mean and standard deviation or median and interquartile interval with confidence interval (CI). To compare cardiorespiratory parameters, the presence of pain and respiratory discomfort before and after passive mobilization, the paired Student t test was used for parametric variables and the Wilcoxon test for non-parametric variables ($p<0.05$).

3. Results

The sample consisted of 27 preterm infants with a gestational age of 30.3±2.8 weeks and a corrected gestational age of 34.5±1.6 weeks (CI: 33.9-35.1). Table 1 shows the characterization of the evaluated sample.

A reduction in HR ($p= 0.006$) (Figure 1) and an increase in SpO_2 ($p<0.001$) (Figure 2) were evidenced, with no changes in the presence of pain and respiratory distress and in RR after passive mobilization (Table 2).

Figure 2. Peripheral oxygen saturation before and after passive mobilization. Wilcoxon Test ($p\leq0.05$).



$Sp0_2$: Peripheral oxygen saturation.
Source: own authorship.

Table 2. Cardiorespiratory variables, presence of pain and respiratory discomfort before and after passive mobilization.

Variables	Before mobilization	After mobilization	p-value
HR (bpm)	153.6±14.9	146.8±14.9	0.006[a]
RR (bipm)	46.5±7.6	44.9±8.0	0.107[a]
SpO_2 (%)	96 (95 – 96.2)	98 (97 - 98)	0.001[b]
NIPS	0 (0 – 0)	0 (0 – 0)	0.317 [b]
SAS	0 (0 – 0)	0 (0 – 0)	0.705[b]

HR: heart rate; RR: respiratory rate; bipm: breath incursions per minute; NIPS: Neonatal Infant Pain Scale; SAS: Silverman Andersen respiratory severity score. Data expressed as mean ± standard deviation and mean and interquartile range. Significant values with $p<0.05$; [a]Paired Student's t-test; [b]Wilcoxon test.
Source: own authorship.

4. Discussion

When evaluating the effect of passive mobilization on the cardiorespiratory parameters of preterm NB, a reduction in HR and an increase in SpO_2 was evidenced, with no change in other cardiorespiratory variables as well as in relation to pain and respiratory discomfort. The mean maternal age observed was 29 years which is, from a reproductive point of view, risky since the age between 20 and 25 years is the period of lowest perinatal risk (Costa *et al*, 2014). RDS is the most frequent cause of admission in the NICU (Santos *et al*, 2012; Boyle *et al*, 2015; Harrison & Goldenberg, 2016), as evidenced in our study.

The sample evaluated presented a mean gestational age that classifies them as late and moderate NB (32-36 weeks)[17]. According to Boyle *et al*. (2015), approximately 75% of deliveries are premature in this population, with admissions to the NICU being usual, greater neonatal morbidity and greater need for monitoring and therapeutic interventions than for those born at ≥37 weeks. In addition, Seethamraju *et al.* (2018) highlighted that the development of respiratory distress, jaundice and hypoglycemia are the most prevalent occurrences after admission in the NICU.

Ramada *et al*. (2013) showed that therapeutic touch, related to tactile and/or kinesthetic stimulation is able to reduce HR and RR. In a study that evaluated the effect of thoracoabdominal rebalancing on the cardiorespiratory parameters of preterm NB, a reduction in RR was observed without a reduction in HR. According to these authors, passive mobilization did not significantly reduce RR, however, it caused a clinically relevant reduction in this variable.

In a systematic review of the effects of therapeutic massage on hospitalized NB, most studies reported that it had a beneficial effect on factors related to the growth of premature babies, due to the increase in vagal activity, gastric activity, and increased levels insulin serum, causing greater neuropsychomotor development, a positive effect on brain development, reduction in the risk of neonatal sepsis, hospital stay and neonatal stress (Alvarez *et al*, 2017).

The study by Diego *et al.* (2014) corroborates with our findings regarding the reduction in HR evidenced after passive mobilization. These authors observed that isolated kinesthetic stimulation decreased cardiac vagal activity, causing a reduction in HR, when compared only to the effects of tactile stimulation. Amaral (2014) showed a reduction in HR and an increase in SpO_2 after tactile, kinesthetic and decubitus changes, and Selestrin *et al.* (2007), when evaluating the variability of HR, RR, SpO_2 and blood pressure of 27 NB with gestational age less than 36 weeks before and after neonatal physiotherapy, showed a reduction in HR and RR, increase in SpO_2 and maintenance of blood pressure.

It is noteworthy that early stimulation aims to facilitate the child's development and that, when performing it, the physiological stability of the NB should be emphasized, with the maintenance of HR between 120 to 180 bpm, SpO_2 close to 100% and the RR between 20 to 50 bipm as criteria for performing passive motor mobilization (Theis *et al*. 2016).

The newborns evaluated in this study did not present respiratory pain and discomfort before passive mobilization and after that they maintained the absence of these clinical signs, which indicates that this procedure did not cause any stress to these preterm infants. Passive mobilization is a conservative method for pain management and physical therapy, together with the multidisciplinary team it aims to reduce harmful stimuli in order to alleviate or avoid pain in these premature NB (Theis *et al*. 2016). Santos *et al*. (2012) showed that tactile and kinesthetic stimulation did not cause pain, however, it caused discomfort in certain manipulations.

The present study had some limitations, such as the low sample size, which made it impossible to stratify the sample according to the classification of prematurity, making it necessary to continue the study in the stratification of extreme, moderate, and late preterm infants. Due to the research design, it is possible to infer that passive mobilization is a safe technique regarding its effects on cardiorespiratory variables and on the generation of pain and respiratory discomfort. Those results are relevant, as with survival of extreme preterms, the sequelae related to neuropsychomotor development could be minimized.

5. Conclusion

Passive mobilization caused a beneficial reduction in heart rate and an increase in peripheral oxygenation after therapy, also, it did not cause pain or respiratory discomfort in the preterm infants evaluated. Knowledge of the effects of passive mobilization in neonates admitted to an intensive care unit may contribute to the improvement of such a therapeutic resource, and it should be emphasized that it must be applied individually and planned according to the clinical development of each neonate. Despite the limited evidence available to date, the implementation of passive mobilization appears to be a viable therapy in neonatal intensive care. However, more studies are needed with standardized intervention protocols and randomized clinical trials to assess the effectiveness of passive mobilization in this population.

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