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Effects of vibration techniques and expiratory flow acceleration on pain parameters in premature infants with pneumonia

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Summary **Purpose:** to evaluate the effects of vibration techniques and expiratory flow acceleration on pain parameters in preterm infants diagnosed with pneumonia hospitalized in the Neonatal Intensive Care Unit and Neonatal Intermediate Care Unit of the Santa Casa de Misericórdia Foundation of Pará, Brazil. **Method:** Randomized clinical trial, in which 28 preterm newborns were randomly divided into two groups: Group 1 - submitted to vibration technique and Group 2 - to expiratory flow acceleration. Both techniques were applied in a range of up to ten minutes, for three consecutive days. Pain indicators were assessed according to the Premature Infant Pain Profile (PIPP) at three times. For statistical analysis, the Friedman tests and Analysis of Variance were applied, the level of significance adopted was 5% ($p < 0.05$). **Results:** Among the preterm infants in Group 1, 64.29% were male, with a mean gestational age of 33.50 ± 2.65 weeks; in Group 2, 57.14% were male, with mean gestational age 33.07 ± 2.84 weeks. Significant changes were observed in the heart rate index, between days, in Group 1 ($p < 0.05$), and in facial mimetic aspects, between times ($p < 0.05$) in both groups. **Conclusion:** The two techniques used did not cause changes that characterized the presence of pain in the newborns studied. However, it is suggested that new research is carried out in order to further elucidate the subject.

Keywords: premature; pneumonia; pain; physiotherapy.

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Introduction

The high incidence of premature births in all the Brazilian regions and its repercussion on neonatal morbimortality rates make prematurity an interesting factor for research. According to recent studies, one in every four extremely premature babies dies a few days after birth[1]. It is known that the preterm newborn (PTNB) is born before 37 weeks of gestational age and the etiology of premature birth is considered complex and multifactorial[2].

Bearing in mind that the PTNB form a risk group for the development of health problems, due to their global immaturity, knowledge and intervention are essential in the various systems of these premature infants, especially in the respiratory system, because this is at a mechanical disadvantage, given the configuration and complacency of the thoracic wall[3].

These conditions may require prolonged use of ventilatory support, a process that triggers an inflammatory cascade and the consequent appearance of ventilatory diseases[4]. These stand out as the main causes of hospital permanence of premature infants, especially pneumonia, considered the main causese of infant mortality worldwide[5].

The physiotherapist, as part of a multidisciplinary team, is extremely important in the care processes, because he uses respiratory physiotherapy in order to improve lung capacity, optimize the ventilatory functions and adjust the ventilation-perfusion ratio, thus avoiding secretion accumulation and preventing respiratory complications[6].

The techniques of vibration and expiratory flow acceleration are physiotherapeutic practices that help in displacing and releasing bronchial secretions, frequently used in neonatology to prevent worsening and minimize consequences of respiratory dysfunctions[6].

Research has cast doubt on whether the techniques of respiratory physiotherapy, vibration and expiratory flow acceleration (physiotherapy techniques) cause pain to the PTNB, because for a long time it was believed that the premature infant was not able to feel pain due to the immaturity of its neurological system[7].

However, it is known that even in these patients, the nociceptor transmission pathways are developed.[8] In clinical practice the physiological[9] and behavioral[10] parameters are assessed to measure pain in the newborn using painful stimulation assessment scales, one of which is the *Premature Infant Pain Profile (PIPP)*.

Given the importance of physiotherapeutic assistance in neonatal care and the few studies on the relationship between the bronchial hygiene techniques and pain in PTNB, the objective of the present study was to assess whether the effects of the vibration and expiratory flow acceleration techniques cause pain to premature infants diagnosed with pneumonia.

Method

A randomized clinical study, in which 28 PTNB participated, diagnosed with pneumonia and hospitalized in the Neonatal Intensive Care Unit (UTIN) and Neonatal Intermediate Care Unit (UCIN) of the Santa Casa de Misericórdia Foundation of Pará (FSCMP), Brazil, from July to October 2016.

The research complied with the ethical principles of Resolution 466/12 of the National Health Council and was started after approval by the FSCMP Committee for Ethics in Research technical advice 1.690.842.

PTNB of both sexes were included study, low weight (1500 to 2500 g) or normal weight (over 2500 g), with clinical diagnosis of pneumonia, using spontaneous ventilation (ambient air or with the help of oxygen therapy), whose caretakers agreed to participate in the research by signing the Free and Enlightened Term of Consent for minors.

Newborn infants were excluded from the study with gestational age of over 37 weeks, with the presence of diseases or procedures that cause pain in the newborn such as necrotizing entercolitis, thoracic traumatism, thoracic or abdominal drain and umbilical catheter, that were less than 72 hours old with birth weight less than 1500 g (very low weight and extreme low weight). Newborn infants were also excluded with invasive or noninvasive mechanical ventilation, sedated, with the use of vasoactive drugs or medication that could interfere in the pain physiological parameters and those whose parents and/or caretakers not sign the TCLE.

The sample was selected from PTNB who met the inclusion criteria and the sample size was determined by the availability and acceptance of the caretaker's participation in the study. To select the sample, initially, the clinical condition of all the hospitalized PTNBs was assessed.

Once included in the study, each patient that was admitted to the UCIN and UTIN was randomly placed by the research director into two groups of 14 PTNB. The premature infants in Group 1 were submitted to the vibration technique (rapid rhythmic movements of isometric contraction of the forearm, applied manually on the anterior region of the thorax)[11] and those in Group 2 to expiratory flow acceleration (gentle compression of the thorax applied with one hand on the lower ribs and the other using cubital edge of the supramammary line)[12].

Both the techniques were carried out with the premature infants positioned in dorsal decubitus, at the time of the expiration phase, with a maximum duration of 10 minutes[13], once a day in the afternoon for three consecutive days and performed by the same physiotherapist. After this procedure, when necessary, the premature infants´ upper airways were aspirated.

The PTNB pain indicators in the two groups were assessed according to the parameters of the Premature Infant Pain Profile (PIPP) at three times, before applying the technique (T1), immediately after applying the technique (T2) and 15 minutes after it finished (T3)[14], by a previously trained researcher who was blindfolded regarding the procedure carried out.

The PIPP is a multidimensional instrument that assesses pain indicators in the PI using the following parameters: gestational age and alert state (contextual factors), heart rate and peripheral oxygen saturation (physiological indicators) that were measured by a (Dixtal®) wrist oximeter and three facial memetic aspects (behavioral factors)[15]. The score ranges from 0 to 21 points, scores lower or equal to 6 indicate absence of pain, scores over 6 represent slight pain and scores higher than 12 indicate presence of moderate to intense pain[16].

The statistical analyses were carried out using the *Statistical Package for Social Science* (SPSS) version 15.0. The tables were produced in *MicrosoftExcel*® 2010. For the inferential analysis, analysis of variance was applied to compare the means of the physiological parameters and the facial mimetic aspects between the days. The Friedman test applied to the data indicated non-normality at the times T1, T2 and T3. The level of significance adopted was 5% ($p< 0.05$).

Results

Among the PTNB analyzed in Group 1, 64.29% (9) were male and 35.71% (5) were female, while in Group 2 57.14% (8) were male and 42.86% (6) were female. The mean gestational age and weight were 33.50 ± 2.65 weeks and 609.43 ± 376.25 grams in Group 1 and 33.07 ± 2.84 weeks and 1550.36 ± 424.09 grams in Group 2. Ambient air was the most frequent ventilation in both groups, with 45.00% (9 PTNB in Group 1) and 71.43% (10 PTNB in Group 2).

Analysis of the physiological parameters between the days showed that in Group 1 there was significant difference at time T2 on the second day and at time T3 on the third day ($p < 0.037$) for the heart frequency indicator, while in Group 2 no significant difference was observed between the days at the three times ($p > 0.023$) (Table 1).

According to the facial mimetic aspects, significant difference was observed in Group 1 between the times for the aspects of frowning ($p < 0.001$) and tightly closed eyes ($p < 0.004$), while in Group 2 significant difference was observed between the times for all the aspects: frowning ($p < 0.005$), tightly closed eyes ($p < 0.035$) and the nasolabial groove ($p < 0.004$) (Table 2). No significant difference was observed ($p > 0.05$) in the assessments of the same facial aspects between the days in either of the groups (Table 3).

Discussion

According to Coutinho et al. [17], physiotherapeutic interventions have provided significant benefits for PTNB and low-weight premature infants. Campos et al.[18] observed that respiratory physiotherapy stabilizes the hemodynamic variables and is considered fundamental in the treatment of pneumonias.

The present study was chosen because it is known that prematurity associated to the presence of very low birth weight predisposes PTNB to a higher risk of the occurrence of problems during the neonatal period[19].

The literature reports that morbidity and increased hospitalized time can result from a lack of tools that verify the presence of pain in clinical practice[20]. To decrease the subjectivity and favor clinical assessment of pain, multidimensional scales have been used to assess the painful stimulus[21], including the PIPP scale, indicated for premature newborns, because it takes into consideration the alterations particular to this group of patients and therefore we chose to use this scale.

Table 1. Data of the physiological parameters of the PTNB hospitalized in the UCIN and UTIN at FSCMP, 2016, according to the day

Physiological Parameters (GROUP 1)	Day	Moment		
		T1*	T2*	T3*
Heart Rate (beats per minute)	1º	(0.43 ± 0.76)	(0.21 ± 0.58)	(0.36 ± 0.84)
	2º	(0.36 ± 0.63)	(0.57 ± 0.85)	(0.43 ± 0.51)
	3º	(0.43 ± 0.85)	(0.29 ± 0.61)	(0.07 ± 0.27)
		0,982	**0,037**	**0,023**
Peripheral Oxygen Saturation (%)	1º	(0.14 ± 0.36)	(0.21 ± 0.43)	(0.29 ± 0.83)
	2º	(0.29 ± 0.73)	(0.21 ± 0.58)	(0.07 ± 0.27)
	3º	(0.07 ± 0.27)	(0.14 ± 0.53)	(0.14 ± 0.36)
	***p*[1] value**	0,768	0,971	0,768
Physiological Parameters (GROUP 2)	**Day**	**Moment**		
		T1*	**T2***	**T3***
Heart Rate (beats per minute)	**1º**	(0.36 ± 0.50)	(0.14 ± 0.36)	(0.07 ± 0.27)
	2º	(0.36 ± 0.63)	(0.14 ± 0.36)	(0.14 ± 0.51)
	3º	(0.07 ± 0.27)	(0.21 ± 0.43)	(0.00 ± 0.00)
	***p*[1] value**	0,217	0,852	0,358
Peripheral Oxygen Saturation (%)	**1º**	(0.07 ± 0.27)	(0.00 ± 0.00)	(0.00 ± 0.00)
	2º	(0.07 ± 0.27)	(0.00 ± 0.00)	(0.00 ± 0.00)
	3º	(0.00 ± 0.00)	(0.07 ± 0.27)	(0.00 ± 0.00)
	***p*[1] value**	0,610	0,377	0,000

[1]Analysis of variance; *Moments of evaluation of the pain indicators - before the application of the technique (T1), immediately after the application of the technique (T2) and 15 minutes after (T3).

Table 2. Data of the facial mimetic aspects of the PTNB hospitalized in the UCIN and UTIN at FSCMP, 2016, according to the times

Facial Mimics (GROUP 1)	Moment			*p*[1] value
	T1*	T2*	T3*	
Furrowed brow	(0.07 ± 0.34)	(0.38 ± 0.53)	(0.19 ± 0.45)	**0,001**
Squeezed eyes	(0.14 ± 0.35)	(0.52 ± 0.55)	(0.38 ± 0.62)	**0,004**
Nasolabial sulcus	(0.07 ± 0.26)	(0.12 ± 0.32)	(0.21 ± 0.46)	0,161
Facial Mimics (GROUP 2)	**Moment**			***p*[1] value**
	T1*	**T2***	**T3***	
Furrowed brow	(0.12 ±0.32)	(0.43 ±0.69)	(0.24 ±0.53)	**0,005**
Squeezed eyes	(0.02 ±0.15)	(0.24 ±0.53)	(0.10 ±0.29)	**0,035**
Nasolabial sulcus	(0.02 ±0.15)	(0.21 ±0.46)	(0.02 ±0.15)	**0,004**

[1] Teste de Friedman; *Moments of evaluation of the pain indicators - before the application of the technique (T1), immediately after the application of the technique (T2) and 15 minutes after (T3).

PTNB were excluded from the research who had very low or extremely low weight and were less than 72 hours old, because, according to Silveira and Procianoy[22], intracranial hemorrhage occurs more frequently in the first three days of life in PTNB with birth weight less than 1500 g, so that several factors may contribute to promoting bleeding or its increase, including bronchial hygiene maneuvers.

Table 3. Data of the facial mimetic aspects of the PTNB hospitalized in the UCIN and UTIN at FSCMP, 2016, according to the day

Facial Mimics (GROUP 1)	Day	Moment		
		T1*	T2*	T3*
Furrowed brow	1º	(0.07 ± 0.27)	(0.29 ± 0.47)	(0.07 ± 0.27)
	2º	(0.00 ± 0.00)	(0.57 ± 0.65)	(0.21 ± 0.43)
	3º	(0.14 ± 0.53)	(0.29 ± 0.47)	(0.29 ± 0.61)
	p[1] value	0,554	0,275	0,457
Squeezed eyes	1º	(0.21 ± 0.43)	(0.36 ± 0.50)	(0.29 ± 0.61)
	2º	(0.00 ± 0.00)	(0.43 ± 0.51)	(0.43 ± 0.76)
	3º	(0.2± 0.43)	(0.79 ± 0.58)	(0.43 ± 0.51)
	p[1] value	0,183	0,086	0,791
Nasolabial sulcus	1º	(0.07 ± 0.27)	(0.07 ± 0.27)	(0.36 ± 0.63)
	2º	(0.07 ± 0.27)	(0.14 ± 0.36)	(0.07 ± 0.27)
	3º	(0.07 ± 0.27)	(0.14 ± 0.36)	(0.21 ± 0.43)
	p[1] value	1,000	0,809	0,281
Facial Mimics (GROUP 2)	**Day**	**Moment**		
		T1*	**T2***	**T3***
Furrowed brow	1º	(0.07 ± 0.27)	(0.36 ± 0.63)	(0.43 ± 0.76)
	2º	(0.07 ± 0.27)	(0.29 ± 0.47)	(0.29 ± 0.47)
	3º	(0.21 ± 0.43)	(0.64 ± 0.93)	(0.00 ± 0.00)
	p[1] value	0,422	0,373	0,093
Squeezed eyes	1º	(0.00 ± 0.00)	(0.14 ± 0.36)	(0.14 ± 0.36)
	2º	(0.07 ± 0.27)	(0.14 ± 0.36)	(0.14 ± 0.36)
	3º	(0.00 ± 0.00)	(0.43 ± 0.76)	(0.00 ± 0.00)
	p[1] value	0,377	0,266	0,348
Nasolabial sulcus	1º	(0.00 ± 0.00)	(0.07 ± 0.27)	(0.00 ± 0.00)
	2º	(0.07 ± 0.27)	(0.36 ± 0.50)	(0.07 ± 0.27)
	3º	(0.00 ± 0.00)	(0.21 ± 0.58)	(0.00 ± 0.00)
	p[1] value	0,377	0,281	0,377

[1]Analysis of variance; *Moments of evaluation of the pain indicators - before the application of the technique (T1), immediately after the application of the technique (T2) and 15 minutes after (T3).

Low-weight males predominated, with moderate prematurity and ventilation in ambient air in both the groups. Whereas very low weight females predominated in the clinical research reported by Nicolau and Falcão[23] with extreme prematurity and mechanical ventilation that showed that the systemic arterial pressure of 42 PTNB stayed within the physiological values after respiratory physiotherapeutic procedures, different from the present study.

Pain assessment makes it possible to identify the efficacy of a treatment and predict its continuation, but because the newborn cannot express itself verbally its interpretation becomes more complex[24]. The PIPP scale has been shown to be eligible and effective in identifying pain in various studies, such as that by Pacheco et al.[25], who used it in newborns submitted to trachea aspiration and observed the presence of pain during the procedure, which was considered invasive and painful.

Regarding the physiological aspect, pain can be assessed by measuring the cardiorespiratory parameters, since their occurrence triggers compensatory mechanisms of the autonomous nervous system, that can result in alterations that include the heart and respiratory rates, arterial pressure and oxygen saturation[16].

Selestrin et al.[26] reported that neonatal physiotherapy was shown to be a therapeutic procedure without harmful repercussions regarding variation in the physiological parameters for the treatment of

27 PTNB hospitalized in a UTIN. This finding corroborates with the data of the present research where the physiological parameters were not significantly different between the three moments of pain assessment of the PTNB in both the groups.

Although for Group 1 there was a statistically significant increase in the heart rate indicator in the comparison between the days, the values observed in not reach scores that indicate the presence of pain. This alteration was observed at the assessment time immediately after the vibration technique on the second day. This fact seems to be related to the type of technique applied, as the Group 2 PTNB did not present significant alteration in the values of the physiological parameters at any of the times between the days. However, it is valid to consider that this specific alteration may have been caused by various stressful conditions that existed in the UTIN and UCIN at the time of the procedures, such as noises, continuous strong lights and constant handling[27].

A similar result was described in the study by Antunes et al.[12] where the PTNB heart rate in the post ex-intubation period increased significantly in the group submitted to conventional respiratory physiotherapy but did not alter in the group that received treatment with expiratory flow acceleration.

It was further observed in the PTNB in Group 1 that in spite of the alteration that occurred on the second day, there was a statistically significant decrease in the heart rate indicator at the time 15 minutes after the vibration technique, on the third day. This event may have influenced the clinical improvement of the referred physiological parameter.

This effect was also observed in research by Abreu et al.[28], where the heart rate of 44 PTNB hospitalized in a UTIN with hyaline membrane disease decreased 20 minutes after carrying out respiratory physiotherapy, using the techniques of postural drainage, mechanical and manual vibration therapy on the thoracic box; thoracic percussion; diaphragm stimulation; passive ventilatory pattern, passive-assisted, active-assisted and passive manual expiratory therapy.

In the present study there was also a significant increase in the values of the facial mimetic aspects at the time immediately after applying the technique to both the groups, but the scores obtained in not reach scores above six on the scale, that represents the presence of pain. This suggests that these therapies can induce a state of agitation in the PTNB compared to resting, but do not necessarily cause pain.

Similar results were reported in studies by Lanza et al.[29], Thirteen PTNB hospitalized in a UTIN were submitted to respiratory treatment by the thoracic vibration technique and when assessed at four times using the NFCS scale, presented values with significant statistical difference between the phases, but not above score 3, considered the pain limit.

Thus it was concluded that expiratory flow acceleration caused fewer effects on heart rate while vibration altered fewer facial mimetic aspects in PTNB diagnosed with pneumonia. Neither technique caused alterations in the physiological and behavioral parameters that characterize presence of pain in this profile of patients.

A critical and reflexive assessment of neonatal care is suggested to assess which therapeutic maneuvers should be used in attending the premature infant along with new research with a bigger sample number, to corroborate or contest the findings of this study.

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Author contribuitions:

HAM performed the experimental part and wrote the article; RCCC did the experimental part and wrote the article; DCT co-guided the research; VMFN conducted the final review of the article; RSBR carried out the final revision of the article; PESA guided the research and wrote the article.