

# Manual vibrocompression and nasotracheal suctioning in post-operative period of infants with heart defects

*Vibrocompressão manual e aspiração nasotraqueal no pós-operatório de lactentes cardiopatas*

*Vibrocompresión manual y aspiración nasotraqueal en el post-operatorio de lactantes cardíopatas*

Máira Seabra de Assumpção<sup>1</sup>, Renata Maba Gonçalves<sup>1</sup>, Lúcia Cristina Krygierowicz<sup>2</sup>, Ana Cristina T. Orlando<sup>2</sup>, Camila Isabel S. Schivinski<sup>1</sup>

## ABSTRACT

**Objective:** To evaluate the impact of manual vibrocompression and nasotracheal suctioning on heart (hr) and respiratory (rr) rates, peripheral oxygen saturation (SpO<sub>2</sub>), pain and respiratory distress in infants in the postoperative period of a cardiac surgery.

**Methods:** Randomized controlled trial, in which the assessments were performed by the same physiotherapist in two moments: before and after the procedure. The infants were randomly divided into two groups: Intervention (IG), with manual chest vibrocompression, nasotracheal suctioning and resting; and Control CG), with 30 minutes of rest. Cardiorespiratory data (SpO<sub>2</sub>; hr; rr) were monitored and the following scales were used: Neonatal Infant Pain Scale (NIPS), for pain evaluation, and Bulletin of Silverman-Andersen (BSA), for respiratory distress assessment. The data were verified by analysis of variance (ANOVA) for repeated measures, being significant  $p \leq 0.05$ .

**Results:** 20 infants with heart disease, ten in each group (seven acyanotic and three cyanotic) were enrolled, with ages ranging from zero to 12 months. In the analysis of the interaction between group and time, there was a significant difference in the variation of SpO<sub>2</sub> ( $p=0.016$ ), without changes in the other variables. Considering the main effect on time, only rr showed a significant difference ( $p=0.001$ ). As for the group main effect, there were no statistical differences (SpO<sub>2</sub> –  $p=0.77$ , hr –  $p=0.14$ , rr –  $p=0.17$ , NIPS –  $p=0.49$  and BSA –  $p=0.51$ ).

**Conclusions:** The manual vibrocompression and the nasotracheal suctioning applied to infants in postoperative of cardiac surgery did not altered SpO<sub>2</sub> and rr, and did not trigger pain and respiratory distress. [Brazilian Registry of Clinical Trials (ReBEC): REQ: 1467].

**Key-words:** physical therapy modalities; infant; thoracic surgery; pain; postoperative care.

## RESUMO

**Objetivo:** Verificar a repercussão da vibrocompressão manual e da aspiração nasotraqueal sobre os parâmetros cardiorrespiratórios de frequência cardíaca (fc) e respiratória (fr), saturação periférica de oxigênio (SpO<sub>2</sub>), dor e desconforto respiratório, em lactentes no pós-operatório de cirurgias cardíacas.

**Métodos:** Estudo controlado e randomizado, com as avaliações realizadas pela mesma fisioterapeuta, em dois momentos: antes e após o procedimento. Dividiu-se o total de lactentes, por sorteio simples, em dois grupos: Intervenção (G<sub>I</sub>), com vibrocompressão manual torácica, aspiração nasotraqueal e repouso; e Controle (G<sub>C</sub>), com 30 minutos de repouso. Avaliaram-se os dados cardiorrespiratórios (SpO<sub>2</sub>; fc; fr), aplicando-se as escalas: *Neonatal Infant Pain Scale* (NIPS), para analisar a dor, e Boletim de Silvermann-Andersen (BSA), para verificar o desconforto respiratório. Os dados foram tratados por meio de análise de variância (ANOVA) para medidas repetidas, sendo significante  $p \leq 0,05$ .

Instituição: Hospital Pequeno Príncipe e Universidade do Estado de Santa Catarina (Udesc), Florianópolis, SC, Brasil

<sup>1</sup>Udesc, Florianópolis, SC, Brasil

<sup>2</sup>Hospital Pequeno Príncipe, Curitiba, PR, Brasil

Endereço para correspondência:

Máira Seabra de Assumpção

Rua Desembargador Pedro Silva, 2.034, bloco 07, apto: 24 – Coqueiros

CEP 88080-700 – Florianópolis/SC

E-mail: mairaassumpcao@yahoo.com.br

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**Resultados:** Avaliaram-se 20 lactentes cardiopatas, dez em cada grupo (sete acianóticos e três cianóticos), com idades de zero a 12 meses. Para analisar a interação entre o grupo e o tempo, observou-se diferença significativa na variação da  $SpO_2$  ( $p=0,016$ ), sem alteração nas demais variáveis. Já o comportamento dos parâmetros nos tempos apresentou diferença significativa apenas na variação da fr ( $p=0,001$ ). Quanto à avaliação do efeito no grupo, não houve diferença estatística em nenhum dos dados ( $SpO_2 - p=0,77$ ; fc -  $p=0,14$ ; fr -  $p=0,17$ ; NIPS -  $p=0,49$  e BSA -  $p=0,51$ ).

**Conclusões:** A vibrocompressão manual e a aspiração nasotraqueal aplicadas em lactentes no pós-operatório de cirurgias cardíacas não prejudicaram a  $SpO_2$  e a fr, além de não desencadear dor e desconforto respiratório. [Registro Brasileiro de Ensaios Clínicos (ReBEC): REQ: 1467].

**Palavras-chave:** modalidades de fisioterapia; lactente; cirurgia torácica; dor; cuidados pós-operatórios.

## RESUMEN

**Objetivo:** Verificar la repercusión de la vibrocompresión manual y de la aspiración nasotraqueal sobre parámetros cardiorrespiratorios de frecuencia cardíaca (fc) y respiratoria (fr), saturación periférica de oxígeno ( $SpO_2$ ), dolor y dificultad respiratoria, en lactantes en el post-operatorio de cirugías cardíacas.

**Métodos:** Estudio controlado y randomizado, con las evaluaciones realizadas por la misma fisioterapeuta, en dos momentos: antes y después del procedimiento. Se dividió el total de lactantes en dos grupos, por sorteo simple: Intervención ( $G_1$ ), con vibrocompresión manual torácica, aspiración nasotraqueal y reposo; y Control ( $G_2$ ), con 30 minutos de reposo. Se evaluaron los datos cardiorrespiratorios ( $SpO_2$ ; fc; fr), aplicándose las escalas: Neonatal *Infant Pain Scale* (NIPS), para analizar el dolor, y Boletín de Silvermann-Andersen (BSA), para verificar la dificultad respiratoria. Los datos fueron tratados mediante análisis de variancia (ANOVA) para medidas repetidas, siendo significativa  $p \leq 0,05$ .

**Resultados:** Se evaluaron 20 lactantes cardiopatas, diez en cada grupo (siete acianóticos y tres cianóticos), con edades de cero a 12 meses. Para analizar la interacción entre el grupo y el tiempo, se observó diferencia significativa en la variación de la  $SpO_2$  ( $p=0,016$ ), sin alteración en las demás variables. El comportamiento de los parámetros en los tiempos, a su vez, presentó diferencia significativa

solamente en la variación de la fr ( $p=0,001$ ). Respecto a la evaluación del efecto en el grupo, no hubo diferencia estadística en cualquiera de los datos ( $SpO_2 - p=0,77$ ; fc -  $p=0,14$ ; fr -  $p=0,17$ ; NIPS -  $p=0,49$  e BSA -  $p=0,512$ ).

**Conclusiones:** La vibrocompresión manual y la aspiración nasotraqueal aplicadas a lactantes en el post-operatorio de cirugías cardíacas no perjudican la  $SpO_2$  y la fr, además de no desencadenar dolor y dificultad respiratoria.

Registro Brasileño de Ensayos Clínicos (ReBEC): REQ: 1467.

**Palabras clave:** modalidades de fisioterapia; lactante; cirugía torácica; dolor; cuidados post-operatorios.

## Introduction

Congenital hearts diseases are one of the main causes of death in newborn infants<sup>(1)</sup> and, in most cases, their etiology is not known yet. However, it is known that several causes are associated with their occurrence, such as prenatal and genetic factors, as well as maternal age<sup>(2)</sup>. Congenital heart diseases may be classified and divided into two groups: acyanotic and cyanotic, based on pulmonary circulation conditions, such as blood volume, flow, venocapillary pressure, and resistance<sup>(3)</sup>.

In the last two decades, technological advances and improvements, both in the identification and treatment of congenital heart diseases, contributed to the knowledge of their pathophysiology and their impact. In this sense, it is currently known that cardiac surgical corrections lead to a number of complications in the newborn and the infant, especially respiratory alterations. These complications are related to poor pulmonary and cardiac function in the pre-operative period, prolonged extracorporeal circulation, and high degree of sedation<sup>(4)</sup>.

In this context, these children usually exhibit abnormalities of respiratory mechanics. Increases in pulmonary artery pressure and pulmonary blood flow are associated with decreased lung compliance and increased airway resistance<sup>(5)</sup>. Hence, alterations in cardiorespiratory data become evident, as well as the manifestation of signs of respiratory distress, defined, according to the Brazilian Society of Pediatrics, as increased respiratory rate, effort or inadequate thoracic excursion, decrease in peripheral breath sounds, groaning breath or shortness of breath, decreased level of consciousness or response to pain, decreased muscle tone, or the presence of cyanosis<sup>(6)</sup>. The analysis of these parameters is routine in the care of infants with heart disease at Intensive Care Units (ICU).

The measurement and quantification of these data contribute to more comprehensive evaluations, especially in the control of manipulations, therapies and interventions. Pain is another element that requires attention, because it causes behavioral changes due to the lability of this group and its clinical condition.

In face of impaired breathing, a common event in the postoperative period, respiratory physiotherapy is recommended and significantly acts for a better prognosis in pediatric patients who underwent cardiac surgery. Its role is recognized in the prevention and treatment of pulmonary complications, by means of specific techniques<sup>(7,8)</sup>. However, in the pediatric population with heart disease, there are still few studies on the impact of conventional respiratory techniques, described in the 1994 Consensus of Lyon<sup>(9)</sup> as those designed to remove bronchial secretions, notably manual vibration, nasotracheal suctioning, postural drainage, chest percussion, chest compression, and cough. Despite of that, these are routine techniques in intensive care units<sup>(10)</sup>, i.e., although the indication for physiotherapy in these patients is found in the literature<sup>(11-13)</sup>, the impact of these techniques is little discussed or addressed when it comes to infants diagnosed with acyanotic or cyanotic heart diseases, in the postoperative period of cardiac surgery.

In view of these factors, the present study evaluated the impact of manual vibrocompression and nasotracheal suctioning on cardiorespiratory parameters, such as heart rate (hr), respiratory rate (rr), and peripheral oxygen saturation (SpO<sub>2</sub>), as well as on respiratory distress and pain, in infants in the postoperative period of cardiac surgery. In this sense, we expect that conventional physiotherapeutic techniques — manual vibrocompression and nasotracheal suctioning — may provide a positive impact on the above-mentioned parameters.

## Method

This is a randomized controlled trial, approved by the Research Ethics Committee (CEP 998-11) of Hospital

Pequeno Príncipe, Curitiba, Southern Brazil. Data from the cardiology ICU of the hospital were collected from November 2011 to February 2012. Before including the infants, their guardians were informed on the purposes, procedures, risks and benefits of the study and expressed their agreement in participating in the study by signing a written informed consent.

Infants of both genders from zero a 12 months and diagnosed with acyanotic or cyanotic congenital heart disease in the postoperative period of cardiac surgery were included in the study (Table 1). All of them were extubated, hemodynamically stable, and were not using sedatives or analgesics on data collection. Patients started respiratory physiotherapy only after medical authorization and prescription.

We excluded infants with neurological and/or neuromuscular diseases, syndromic alterations, open chest, hemodynamic instabilities and those who presented with anasarca or were on peritoneal dialysis. Table 2 describes heart diseases, according to groups, as for type of heart disease, surgical correction, postoperative time (PO), extracorporeal circulation time (ECC), and mechanical ventilation time (MV).

Sample size calculation considered a variation of 3% in SpO<sub>2</sub>, with standard deviation equal to 3, taking into account a significance level of 5% and power of 85% in a two-tailed hypothesis test<sup>(14)</sup>, obtaining a total of nine individuals in each group.

After checking medical charts and evaluating patient's clinical picture together with the medical team, the selected infants were randomly assigned into Control Group (CG) and Intervention Group (IG).

The CG remained at rest for 30 minutes. During this period, there was no manual contact, only visual observation of the parameters evaluated in the study. The IG underwent manual chest vibrocompression for ten minutes (rhythmic and rapid movements of isometric contraction of the forearm, manually applied on the anterior region of the chest, at the quadrants of right and left lung apices simultaneously, in the expiratory phase, associated with chest compression)<sup>(15)</sup>.

**Table 1** - Demographic characteristics of the study patients

Variable	CG	IG	p-value
Post-extubation time (days – mean±SD)	2.10±1.60	2.40±2.50	0.967
Age (months – mean±SD)	4.60±3.72	4.90±4.28	0.790
Gender (Male/female)	5/5	6/4	0.655
Type of surgical incision (MS/LT)	8/2	8/2	1.00
Heart diseases (cyanotic/acyanotic)	3/7	3/7	1.00

CG: Control Group; IG: Intervention Group; MS/LT: median sternotomy / lateral thoracotomy; SD: standard deviation

Then nasotracheal suctioning was performed (for approximately 30 seconds)<sup>(16)</sup>. This procedure lasted for five minutes, including the preparation of the materials, the beginning and the end of the maneuver, and the positioning of the infant on bed; afterwards, 15 additional minutes of rest were considered (visual observation by the examiner). Thus, the session had an overall duration of 30 minutes (manual chest vibrocompression, nasotracheal suctioning, and rest). The intervention was carried out only once, always by the same physiotherapist (MSA), who also conducted all the

described evaluations, always respecting the sequence of the procedures. The study considered the data of an only session for each infant.

Both groups were first evaluated in terms of cardiorespiratory parameters (hr, rr and SpO<sub>2</sub>) and subsequently in terms of signs of respiratory distress and pain, before and after intervention or rest (T<sub>pre</sub> and T<sub>post</sub> respectively).

To evaluate cardiorespiratory parameters, hr and SpO<sub>2</sub> were analyzed by checking the monitor available at the cardiology ICU (Dixtal Monitor Dx2021<sup>®</sup>), recording

**Table 2** - Description of cyanotic and acyanotic heart diseases according to groups, in terms of type of heart disease, surgical correction, postoperative time in days, extracorporeal circulation time in minutes and mechanical ventilation time in days

		Heart disease	Surgical correction	PO	ECC	MV	
CG	Acyanotic	Wide PDA/IVC	Closure of IVC/ PDA	1	74'	1	
		Wide PDA/IVC	Closure of IVC/ PDA	1	80'	1	
		Wide perimembranous IVC	Closure of IVC/banding	3	65'	1	
		Moderate subaortic IVC	Correction of subaortic IVC / Suture and ligation of PDA	4	71'	3	
		Wide perimembranous IVC/PDA	Closure of IVC/ligation of PDA	2	79'	1	
		OSIAC/LPSVC	Atrioseptoplasty	4	37'	1	
		Mitral valve prolapse and Malformation/ mitral stenosis	Implantation of mitral biological Prosthesis	19	–	8	
		Cyanotic	Tricuspid atresia /moderate IVC/IAC	Blalock-Taussing	2	90'	1
	TGV/PA/IVC/IAC/PDA/ <i>situs inversus</i>		Blalock-Taussing	2	–	2	
	Type II <i>truncus</i>		Closure of IVC and IAC/separation Ao from neopulmonary artery	9	89'	8	
	Acyanotic		AVSD/wide PDA	Pulmonary artery bandage/closure of PDA	6	–	5
			Wide IVC/PDA	Closure of IVC	4	108'	1
			Wide perimembranous IVC/PDA	Correction septoplasty/ligation and section of PDA	5	75'	3
		Type A AI with ventricular inversion/ IVC/PDA	Damus Kaey/opening IAC/aortic pulmonary anastomosis	25	178'	18	
IVC/PS IV		Closure IVC with goretex patch, infundibular resection	2	85'	1		
Atrial isomerism/TAVSD/ VDRVVO/ Moderate pulmonary stenosis		Drainage of pulmonary veins for LA	8	77'	7		
Wide aortopulmonary window/ OSIAC/increased heart chambers		Correction of aortopulmonary window/closure of IAC	4	36'	2		
Cyanotic	Tricuspid atresia/hypoplastic RV/ Restrictive IVC/IAC	Blalock-Hanlon/anastomosis	7	–	3		
	TOF/PDA	Blalock-Taussing	11	101'	10		
	TOF of good anatomy	Pulmonary infundibular resection/ Closure of IVC	3	115'	4		

CG: control group; IG: intervention group; PDA: persistent ductus arteriosus; IVC: interventricular communication; IAC: inter-atrial communication; OSIAC: *ostium secundum* inter-atrial communication; LPSV: left persistent superior vena cava; TGV: transposition of the great vessels; PA: pulmonary atresia; AVSD: atrioventricular septal defect; TAVSD: total atrioventricular septal defect; Ao: aorta artery; AI: aortic insufficiency; PS IV: grade IV pulmonary stenosis; VDRVVO: ventricular defect with right ventricular volume overload; LA: left atrium; RV: right ventricle; TOF: tetralogy of Fallot

the prevailing value during one minute. Rr was counted for one minute by observing infant's chest and abdominal movements, in order to confirm the beginning and the end of each respiratory cycle.

Subsequently, signs of respiratory distress were investigated by the Bulletin of Silvermann-Andersen (BSA), used in other studies with infants<sup>(17-21)</sup> and described for use beyond the neonatal period in the *Série de Atualização de Reciclagem em Pneumologia* of the *Sociedade Paulista de Pneumologia e Tisiologia* (SPPT), in 2011<sup>(22)</sup>. The BSA assesses the following items: expiratory grunting, nostril flaring, intercostal retraction, sternal retraction, and paradoxical breathing. Its score ranges from zero (no respiratory distress) to ten (maximum respiratory distress), with the score from one to five being considered moderate distress, and, from six to ten, severe distress<sup>(23)</sup>.

The Neonatal Infant Pain Scale (NIPS) was used to evaluate pain. This scale considers the following parameters: facial expression (zero or one point), cry (zero, one or two points), breathing patterns (zero or one point), position of legs (zero or one point), position of arms (zero or one point) and state of arousal (zero or one point). Pain is present when the score is higher than or equal to four<sup>(24)</sup>. The NIPS was used in infants based on the study by Pereira et al<sup>(25)</sup> and on the document entitled *Atenção à saúde do recém-nascido: Guia para profissionais de saúde*<sup>(26)</sup>. None of these references validate the application of this scale beyond the neonatal period. Despite this limitation, its use is justified by the lack of instruments of this nature in the aforementioned age group.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 20.0. Results were presented by descriptive and frequency statistics and expressed as means and standard deviation. The behavior

of the variables in the groups (IG and CG) and at the two time points of data collection, T<sub>pre</sub> and T<sub>post</sub>, was assessed by analysis of variance (ANOVA) for repeated measures, with three main effects: time, group and the interaction of both, with significance set at  $p \leq 0.05$ .

## Results

Twenty infants participated in the study, assigning ten in each group. Subjects' age ranged from zero to 12 months, with mean of  $4.67 \pm 3.61$  months in the CG (0.23 to 9.00) and of  $5.04 \pm 4.10$  in the IG (0.50 to 11.00) ( $p=0.790$ ). Table 1 shows age, sex distribution, extubation time, type of corrected heart disease and surgical incision.

Table 3 describes descriptive data for hr, rr and SpO<sub>2</sub> in the IG and in the CG at the two study time points. There was no significant difference in SpO<sub>2</sub> ( $p=0.77$ ), hr ( $p=0.146$ ), rr ( $p=0.166$ ), NIPS ( $p=0.4.88$ ) and BSA ( $p=0.512$ ) between T<sub>pre</sub> and T<sub>post</sub>, in any of the groups.

Considering the interaction between group and time, it was observed that the group in which the infant was assigned at the two time points significantly interfered with the variation in SpO<sub>2</sub> ( $p=0.016$ ), with CG showing a decrease from  $91.5 \pm 4.38\%$  (at T<sub>pre</sub>) to  $90.5 \pm 6.22\%$  (at T<sub>post</sub>); in the IG, there was an increase from  $89.0 \pm 8.73$  to  $91.2 \pm 8.26\%$ , at the T<sub>pre</sub> and T<sub>post</sub>, respectively. On the other hand, with regard to the remaining parameters (hr, rr, NIPS and BSA), group allocation did not have a significant effect ( $p=0.867$ ;  $0.585$ ;  $0.851$ ;  $0.170$ , respectively) (Table 3).

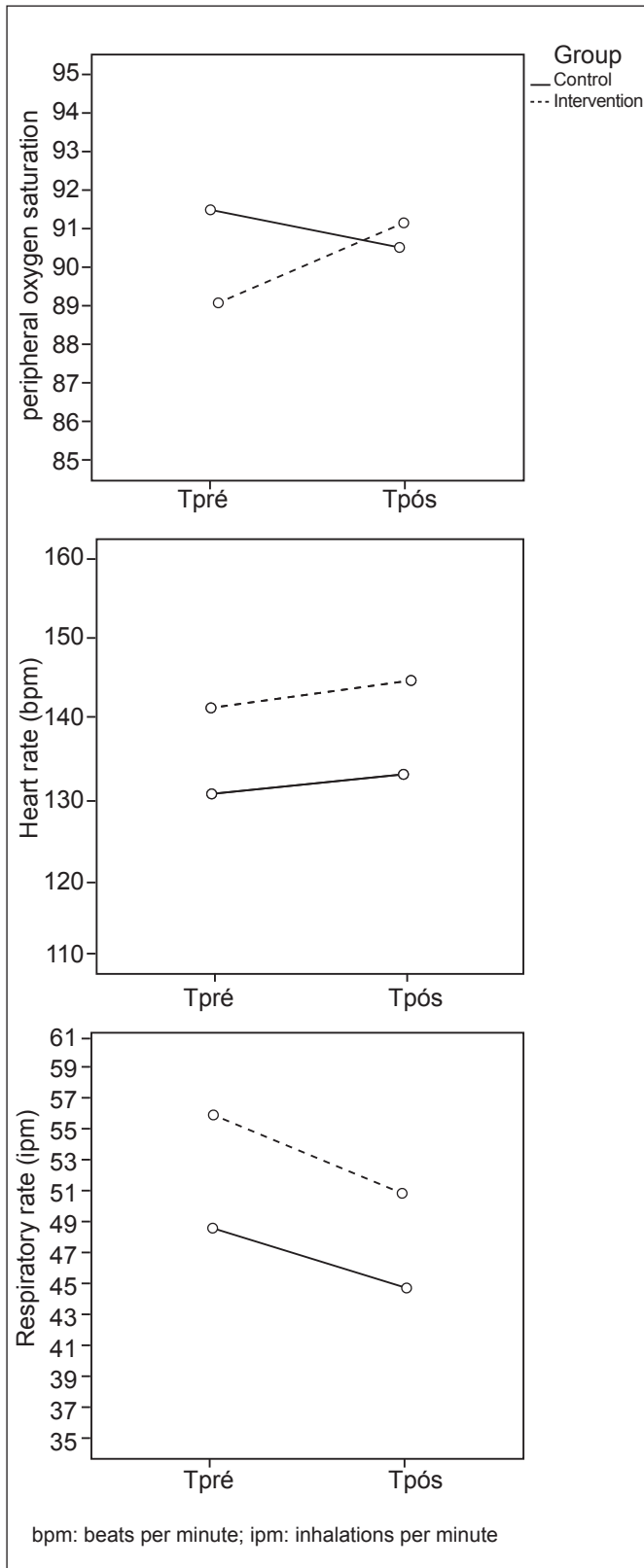
Considering the main effect on time, only rr showed a significant difference ( $p=0.001$ ). In both groups, there was a decrease in this variable from T<sub>pre</sub> to T<sub>post</sub> (from  $56.2 \pm 51.0$  to  $51.0 \pm 11.65$  in the IG and from  $48.6 \pm 11.50$  to  $44.7 \pm 10.58$

**Table 3** - Descriptive data of the cardiorespiratory parameters hr, rr and SpO<sub>2</sub> in IG and CG, before and after one of the procedures (intervention or rest), and the result of the comparison of study parameters at T<sub>pre</sub> and T<sub>post</sub> according to the ANOVA test for repeated measures

Groups		hr (A)				rr (B)				SpO <sub>2</sub> (C)			
		Min	Max	Mean±SD	p-value	Min	Max	Mean±SD	p-value	Min	Max	Mean±SD	p-value
CG	T <sub>pre</sub>	92	154	130±20	0.26*	30	70	49±11	0.001*	82	97	92±4	0.33*
	T <sub>post</sub>	96	175	133±24		0.87**	30	67		45±11	0.59**	78	
IG	T <sub>pre</sub>	127	155	141±10	0.15***	43	78	56±11	0.17***	74	97	89±9	0.78***
	T <sub>post</sub>	123	161	145±14		31	72	51±12		76	100	91±8	

rr: respiratory rate; hr: heart rate; SpO<sub>2</sub>: peripheral oxygen saturation; CG: Control Group; IG: Intervention Group; T<sub>pre</sub>: before the procedures (only rest or manual vibrocompression+nasotracheal suctioning+rest); T<sub>post</sub>: after the procedures (only rest or manual vibrocompression+nasotracheal suctioning+rest); Min: minimum; Max: maximum; SD: standard deviation; p-value: \*for the analysis of the behavior of the variables at pre and post times points; \*\*group and time effect; \*\*\*group effect; F: F-test; df: degrees of freedom





**Figure 1** - Behavior of mean values for respiratory rate (rr), heart rate (hr) and peripheral oxygen saturation (SpO<sub>2</sub>) of infants with heart disease at the different time points (T<sub>pre</sub> and T<sub>post</sub>), in each of the two study groups

in the CG). However, this behavior was not observed in the other variables (Table 3). Figure 1 graphically represents the change in means for rr, hr and SpO<sub>2</sub> before and after the procedures (rest or intervention), according to each group (CG and IG).

As for the main effect on the group, there was no significant difference in any of the study variables: rr ( $p=0.166$ ), hr ( $p=0.146$ ), SpO<sub>2</sub> ( $p=0.777$ ), NIPS ( $p=0.488$ ) and BSA ( $p=0.512$ ) (Table 3).

In the IG, NIPS scores ranged from zero to seven ( $0.90\pm 2.18$ ); in the CG, this variation was also from zero to seven points ( $1.70\pm 2.11$ ). In the IG, one infant had a score compatible with pain at the beginning of the procedure and kept this pattern at the end of assessments. This also happened with one infant in the CG. In addition, eight infants in this group did not have a score corresponding to pain, four of which did not change their score before and after the procedure. One infant who initially had a score compatible with the presence of pain had a score corresponding to the absence of the symptom at the end of the procedure.

As for BSA score for respiratory distress, three infants showed improvement in signs (from moderate to absence) and none of them showed moderate to severe distress after intervention in the IG. In the CG, four infants did not show changes in any of the time points and three showed improvement, with two cases from severe to moderate and one from moderate to absence.

## Discussion

Despite the frequent recommendation of respiratory physiotherapy in the postoperative period of cardiac surgery and the wide range of physiotherapeutic techniques used to revert pulmonary dysfunction or negative pathophysiological changes<sup>(12,27)</sup> in this period, there is no consensus about the best method to use<sup>(28)</sup>.

Manual vibrocompression aims for a better lung deflation, to displace middle airways secretions to proximal airways and thus to the trachea, facilitating the process of mucus elimination<sup>(29-31)</sup>. This mechanism of action is an important aspect to be considered when one aims to assess the efficacy of manual techniques in intensive care<sup>(32)</sup>, like in the present study.

In this study, manual vibrocompression was complemented with nasotracheal suctioning, because infants with heart disease have inefficient physiological mechanisms to remove secretions, and nasotracheal suctioning is recommended as

an airway clearance method in these situations<sup>(16)</sup>. The concern to investigate the effect of combined physiotherapeutic techniques (manual vibrocompression and nasotracheal suctioning) had the purpose of portraying the routine care of physiotherapists in ICUs for the management of infants with heart disease, since compromised respiratory function and mechanics is a frequent finding in this clinical situation<sup>(11,33)</sup>.

In view of the foregoing, it was observed that the results shown in this study did not have a negative impact on cardiorespiratory parameters. There was an increase in SpO<sub>2</sub> after therapy, which did not happen with the group that did not receive the intervention (CG). Although this 2% increase (from 89% to 91%) has arguable clinical relevance, because it is a little variation that is within the margin of error of pulse oximetry, it become evident that physiotherapeutic procedures are not harmful for this type of patient, a topic that is routinely discussed in the postoperative management of patients with heart disease. This is because the physiotherapeutic procedures analyzed here did not cause clinical harms, such as hemodynamic instability, tachycardia or bradycardia, tachypnea and desaturation. On the contrary, there was an increase in oxygenation and reduction in respiratory rate, which deserves further investigations. The increase in sample size could reveal greater differences between the groups.

A study that evaluated the effects of manual vibration in infants with acute viral bronchiolitis, conducted by Pupin *et al*<sup>(34)</sup>, combined this maneuver with postural drainage and compared them with the expiratory flow increase technique (EFIT). In the sample of 27 infants who underwent manual vibration (intervention group), no benefit was observed in terms of oxygenation. None of the techniques used lead to an improvement in the cardiorespiratory parameters hr, rr and SpO<sub>2</sub>. The authors reported that the effect of the two therapies, when analyzed over time (ten minutes after the end of the procedure), seems to contribute to decrease only rr.

Following this same line of studies evaluating the effects of manual vibration on cardiorespiratory parameters, Lanza *et al*<sup>(35)</sup> evaluated the behavior of 13 preterm newborns after performing the maneuver, for approximately 17 minutes. No detrimental effects were identified after this therapy in terms of pain signs (according to the Neonatal Facial Coding System scale) and of the parameters rr, hr and SpO<sub>2</sub>, which remained within the normal range. The authors descriptively observed an increase in hr immediately after the maneuver, as well as a decrease in rr and an increase in SpO<sub>2</sub>, which remained after 30 minutes.

With regard to the effects of nasotracheal suctioning, Falcão and Silva<sup>(36)</sup> found a decrease in SpO<sub>2</sub> in 13 newborns who underwent this procedure alone, compared to the group that received the same procedure, but combined with containment maneuvers. Hr also had a greater variation after the use of nasotracheal suctioning alone.

It is important to emphasize that confronting the findings from the present research with studies involving different populations is justified by the lack of clinical trials with children with heart diseases.

One of the few investigations on the subject was developed by Reines *et al*<sup>(37)</sup>, who were not able to prove the benefits of respiratory physiotherapy in patients who underwent surgical correction of congenital heart diseases. This study included 44 children, aged from three months to nine years and randomized into two groups. One of them underwent maneuvers of postural drainage, vibration, decubitus positions, nasotracheal suctioning of airways, deep breathing, and requested or stimulated cough. In the other group, patients received only nasotracheal suctioning, deep breathing, and requested or stimulated cough, without physiotherapeutic maneuvers. According to the authors, respiratory physiotherapy should be recommended to patients in whom its benefits have been proven, especially those with large amount of sputum production, and not as a routine for the prophylaxis of atelectasis in the postoperative period, because the group that received physiotherapeutic maneuvers developed atelectasis with a significantly higher frequency than the group that did not.

A more recent study involving infants with heart disease reported a series of 14 cases of babies diagnosed with acyanotic congenital heart diseases. They were randomized into three groups: control; placebo (only gentle manual contact in the chest); and intervention group, whose participants received two supports of the method of thoracic-abdominal rebalance (TAR) during ten minutes. Cardiorespiratory parameters, respiratory distress and pain were assessed by the same instruments used in the present study. Results showed that the four infants in the intervention group had an increase in hr and SpO<sub>2</sub> and a decrease in rr. None of the infants expressed pain after the physiotherapeutic intervention with TAR<sup>(38)</sup>. Although this study analyzes a physiotherapeutic technique different from that used in the present investigation, both studies exhibit positive results with respiratory physiotherapy performed in this type of patient.

Another issue to be discussed is the fact that pain, as well as alterations in cardiorespiratory parameters and the

presence of respiratory distress, leads to changes in infant's behavior. Therefore, its quantification contributes to more comprehensive assessments. When it comes to heart diseases, pain is the main manifestation reported by patients who underwent cardiac surgery and has a multifactorial nature<sup>(39)</sup>. The factors that influence in pain may be: surgical incision, intraoperative tissue retraction and dissection, multiple intravenous cannulations, chest tubes, and invasive procedures that these patients undergo during their therapeutic regimen<sup>(40)</sup>. Considering that pediatric patients do not verbalize their painful feeling and that it may be caused or potentiated by different procedures and manipulations, assessing it after the use of physiotherapeutic techniques is of great clinical relevance. In this sense, it was observed that manual vibrocompression and nasotracheal suctioning, applied in infants with heart disease, were not triggering factors for pain. The divergence between the findings from the present study and those from other publications may result from different clinical situations, patients' age, and severity of the disease. Additionally, in this investigation, there was a concern about how to apply vibrocompression. Considering that the type of surgical incision may itself have an influence on pain, the manual technique was carefully performed so that it was not applied with an aggressive manual pressure on infant's chest. Regardless of the type of incision, both in lateral incision and in median sternotomy (which corresponded to 80% of the cases), we took the same level of care.

Another important issue refers to the scales used in this paper. Our small study sample included newborns and infants, applying scales for pain and respiratory distress validated for neonates (NIPS and BSA), since the literature does not provide specific compatible tools that take exactly into account the second age group (infants). However, other researchers who evaluated infants used similar instruments in their investigations<sup>(17-21,25,26)</sup>. These scales are simple, based on the evaluation of clinical signs routinely observed in the management of the pediatric patient and, thus, we decided for its use in the entire sample, standardizing the assessment instrument. However, future studies should be conducted to

develop scales designed for this type of assessment in infants, contributing for the adequacy of methodology and of the results obtained in this line of research.

In view of the foregoing, the association of manual vibrocompression and nasotracheal suctioning was favorable in the postoperative of pediatric cardiac surgery, both due to the increase in SpO<sub>2</sub> and the decrease in rr and due to the absence of detrimental effects in pain and respiratory distress. Studies point out the effectiveness of physiotherapy in these cases, emphasizing its use as a routine procedure for the reduction in pulmonary complications<sup>(13,41,42)</sup>. However, there is little scientific evidence about the most appropriate techniques and their effects in this context and on this age group. The existing studies also show small samples, variability in therapeutic protocols and different clinical situations, which makes comparisons difficult. Its consensus<sup>(31)</sup> that the choice for the pediatric therapy for airway clearance should have as basic principles anatomic and physiological differences, the existing pathological processes, and the specificities of each age group<sup>(43)</sup>.

It is important to point out some limitations of the study. Data collection was a difficult procedure, due to the complexity of the cases and the rigorous physiotherapeutic protocol. This prevented the sample from being larger. The classification of patients' clinical severity into mild, moderate or severe would also have contributed even more to the quality of the investigation. Another factor to be discussed refers to the use of neonatal scales (NIPS and BSA) in older children. The application of instruments specific for infants may improve the accuracy of the results. Finally, the scarcity of investigations on the subject made it impossible to perform more detailed analyses and comparisons of the results obtained in this study with those obtained by other methods and conducts.

It can be considered that the physiotherapeutic techniques of manual vibrocompression and nasotracheal suctioning, applied to infants in the postoperative period of cardiac surgery, did not alter SpO<sub>2</sub> and rr in the treated group and did not trigger pain signs and respiratory distress.

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