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Cardiorespiratory parameters in infants cardiopathy: variations during feeding

Parâmetros cardiorrespiratórios em bebês cardiopatas: variações durante a alimentação

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Keywords

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Deglutition Disorders
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ABSTRACT

Purpose: To evaluate the variation of cardiorespiratory parameters in the feeding of cardiopathy infants. **Methods:** A cross-sectional, controlled study was performed on infants from 0 to 6 months of age, both genders, at a referral hospital for pediatric cardiac surgery. They were divided into a group study of infants with a medical diagnosis of congenital heart disease, post-cardiac surgery and in a control group composed of infants with no co-morbidities pre-established as risk factors for dysphagia. Vital signs monitoring and pulse oximetry were performed before, during and after clinical evaluation of swallowing in both groups. **Results:** There was a significant difference in heart rate between the two groups prior to the evaluation, however, a marked increase was observed in the study group during the oral route. The respiratory rate variation was significant during the maternal breast offer in the study group, which also showed a greater decrease in saturation when compared to the control group. **Conclusion:** There is variation of cardiorespiratory parameters during feeding of cardiopathy infants.

Descritores

Cardiopatias
Transtornos de Deglutição
Lactente
Sinais Vitais
Oximetria

RESUMO

Objetivo: Verificar a variação dos parâmetros cardiorrespiratórios na alimentação de bebês cardiopatas. **Método:** Estudo transversal controlado, realizado com bebês de 0 a 6 meses de idade, de ambos os gêneros, em um hospital de referência para cirurgia cardíaca pediátrica. Foram divididos em grupo de estudo os bebês com diagnóstico médico de cardiopatia congênita, pós-cirurgia cardíaca e em grupo controle, composto de bebês sem comorbidades pré-estabelecidas como fatores de risco para disfagia. Realizada monitorização de sinais vitais e oximetria de pulso antes, durante e após a avaliação clínica da deglutição nos dois grupos. **Resultados:** Há diferença significativa da frequência cardíaca entre os dois grupos já anterior à avaliação, porém foi observado aumento acentuado do parâmetro no grupo estudo durante a oferta de via oral. A variação da frequência respiratória foi significativa durante a oferta de seio materno no grupo estudo, que também apresentou maior queda de saturação quando comparada a do grupo controle. **Conclusão:** Há variação de parâmetros cardiorrespiratórios durante alimentação de bebês cardiopatas.

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INTRODUCTION

Congenital heart disease (CD) is the set of diseases that affect the cardiovascular system including heart, pericardium, arteries, veins and capillaries[1], defined as an abnormality either in structure or in cardiovascular function which is present at birth[2]. They may occur at any age and may have symptoms and physical signs such as: bloating, cyanosis, low weight gain, tiredness, sweating, tachycardia, cardiomegaly, abnormal blood pressure, pulse changes, recurrent pulmonary infections, chest pain, syncope and difficulty in eating, among others[3].

Currently, the diagnosis of heart diseases has become more precise and can be done through clinical manifestations, echocardiographic and radiological studies. In this way, hemodynamic changes can also be better understood, allowing knowledge of the general conditions of the child[4].

Cardiorespiratory parameters are important data for evaluating the cardiovascular system in infants. Heart rate (HR), respiratory rate (RF) and pulse oximetry data measured by peripheral oxygen saturation (POS) can be observed during swallowing[5,6] and allow the clinical evaluation of deglutition to be more measurable and less subjective[7].

Due to the clinical conditions inherent to cardiac alterations, children with CHD have inadequate biological utilization of available nutrients due to high energy expenditure[8]. Also, they may take longer to feed due to cardiopulmonary impairment[9]. This feeding difficulty may or may not be associated with oropharyngeal dysphagia[10,11].

Studies have demonstrated swallowing disorders in post-cardiac surgery infants and the incoordination between suckling, swallowing and breathing has been identified[12,13] and may be associated with changes in cardiorespiratory parameters during feeding. A recent study[14] showed alterations in the biodynamics of swallowing of cardiac infants in the oral and pharyngeal phases, presence of dysphagia in a large number of the studied population, besides associating a greater presence of dysphagia in babies fed by the bottle when compared to those fed in the maternal breast in this population.

It is believed that there is variation of cardiorespiratory parameters in the feeding of cardiac patients, unlike in infants without risk factors for dysphagia. And that this difference in parameters may be associated with difficulty swallowing. However, there are still few studies that have isolated CD for its identification as a risk factor for dysphagia in the pediatric population. Also, changing the presentation of vital signs before and during feeding may aid in clinical speech-language diagnosis. Therefore, this study aims to evaluate the variation of cardiorespiratory parameters in the feeding of cardiopathy infants.

METHODS

The study was approved by the Human Research Ethics Committee of the Santo Antônio Children's Hospital (Opinion no. 1,324,927 / 2016) and performed after the signing of the free and informed consent form.

This is a cross-sectional, controlled study conducted at a philanthropic referral hospital for pediatric cardiac surgeries in southern Brazil, between November 2015 and September 2016. Participants in the study group (SG) were babies from 0 to 6 months of age, of both genders, with a medical diagnosis of congenital heart disease, post-cardiac surgery, with clinical stability for reintroduction or introduction of oral route - identified by medical staff - who were hospitalized in a Pediatric Intensive Care Unit (PICU) and met the in speech and hearing conditions for oral testing (cutoff point above 28 in the Early Feed Readiness Assessment Instrument for Beginning of Oral Feeding)[15]. Babies with structural alterations of the upper airways, associated neurological impairments, viral respiratory condition at the time of evaluation, chronological age corrected below 38 weeks, suspected or diagnosed of genetic syndrome and who were already in speech therapy were excluded.

The control group (CG) was composed of infants from 0 to 6 months, of both genders, who were in the admitted to hospital. Patients with upper respiratory tract structural changes, associated neurological impairment, viral respiratory condition at time of evaluation, chronological age corrected below 38 weeks, suspicion or diagnosis of a genetic syndrome, who were in speech therapy at or prior to admission and who had CC were excluded.

As a criterion for selection of the infants of the SG, the Instrument for the Evaluation of the Early Premature Infant Feeding Assessment[15] was applied. The protocol consists of five categories: corrected age; state of behavioral organization; oral posture; oral reflexes; and non-nutritive sucking. The score ranges from 0 to 36 points, with 28 being the cut-off point to follow the evaluation. Such instrument was applied by a speech therapist of the service, as routine of the ICU, to verify oral readiness of these patients.

After being selected, the infants of both groups were submitted to the same evaluation procedures. The clinical evaluation of swallowing was performed using the Pediatric Dysphagia Assessment Protocol (PAD-PED)[16] to identify intercurrences during swallowing and to collect cardiorespiratory parameters. The instrument consists of an initial part of anamnesis and feeding history of the child, an evaluation of stomatognathic system structures, clinical evaluation of swallowing, food supply, and conclusion of the protocol, with the classification of speech-language diagnosis. For this study, the items of the child's food history, food supply in the mother's womb or with bottle and the final part of the conclusion were used.

The choice of the evaluation form - mother's womb or bottle - was given through the patient's previous feeding history, with the usual utensil. If the baby did not receive oral feeding prior to the evaluation, it was recommended evaluation in the mother's womb and-if not possible, evaluation in a bottle with a conventional medium flow nozzle. In the evaluation, at least half of the prescribed diet was offered or, in case of signs of laryngotracheal penetration and / or aspiration, the supply was interrupted.

In both groups, portable monitors were used to verify cardiorespiratory parameters. Whenever the researchers considered it necessary, they requested the attachment of new electrodes and a pulse oximeter, for greater veracity of the information collected. When large movements were made with the limb in which the oximeter sensor was attached, the data was disregarded. For the recording of RF in the CG, the number of respiratory cycles that the patient performed for one minute, before and during the feeding, was observed. A nursing technique followed the collection and noted the cardiorespiratory parameters presented before, during and after the evaluation.

The application of each protocol was performed individually by a speech therapist. During the total period of the study, two professionals with experience in the area of pediatric dysphagia, after establishing criteria and training for uniformity of collection, gathered all the data.

The data collected related to the quantitative variables age and cardiological diagnosis were described by mean and standard deviation. Categorical variables, current feeding route, protocol conclusion, type of congenital heart disease by absolute and relative frequencies. To compare means, independent and paired Student's T-Test was applied. Already the interaction between the variation of the cardiorespiratory parameters, during the evaluation, was evaluated by the ANOVA for repeated measures with adjustment by Bonferroni. The significance level adopted was 5% ($p < 0.05$) and the analysis was performed in the SPSS program version 21. The data will be presented descriptively and in tables with verified statistical significance marked with an asterisk (*).

RESULTS

Table 1 shows the characterization of the study sample, both in SG and CG, composed of 31 babies, identifying the age, feeding route at the time of evaluation and the result of the clinical evaluation of swallowing[5]. There was a difference between the two groups regarding the feeding route at the time of evaluation and the conclusion of the protocol (speech-language diagnosis). Table 2 presents the characterization of EE regarding type and cardiological diagnosis.

In Table 3, SG and CG were divided by the feeding form in the speech-language evaluation: mother's womb or bottle. There was a difference in the comparison (from before to during feeding) of the signs of RF, FC and POS in the group with heart disease, both in the mother's womb and in the bottle. There was also a statistically significant difference ($p = 0.029$) in the variable POS in mother's womb in the CG, which showed improvement of the parameter during breastfeeding.

We identified HR prior to the clinical evaluation of swallowing, with significant difference between groups ($p < 0.001$), and this remained in the verification during the supply ($p < 0.001$). However, the SG presented a greater increase than the controls ($p = 0.004$) of the HR.

There was no significant difference in pre-breastfeeding RF ($p = 0.234$) between the groups, but there was a significant difference ($p = 0.003$) in the measurement during feeding. Thus, SG presents a higher increase in RF than controls ($p < 0.001$) in the pre-feeding period for the period during breastfeeding.

The comparison of POS between the two groups presents a significant result before feeding ($p = 0.002$), which remains in the period during the evaluation ($p = 0.001$). However, it was identified that the CG presented a greater increase of the variable than the SG ($p < 0.001$), which significantly reduced saturation during breastfeeding.

It should be noted that the comparisons of HR, RR and POS were performed in mother's womb, between the SG and GC, since the GC presented only 2 babies with bottle feeding. In SG, changes in vital signs and pulse oximetry were not associated with the intercurrent variable during feeding ($p > 0.20$) nor with the presence of dysphagia, defined by the conclusion of the protocol as set forth in Table 4.

Table 1. Characterization of the study sample

Variables	Group Study (n=31)	Control Group (n=31)	P
Age (days) – md (P25 – P75)	21 (13 - 42)	27 (14 - 90)	0.328
Via current feed – n(%)			<0.001*
Oral Rout	17 (54.8)	31 (100)	
Nasoenteric probe	6 (16.1)	0 (0.0)	
Orogastric probe	1 (3.2)	0 (0.0)	
Oral route + Alternative route	8 (25.8)	0 (0.0)	
Conclusion – n(%)			<0.001*
Normal swallowing	8 (25.8)	31 (100)	
Oropharyngeal Dysphagia Mild	10 (32.3)	0 (0.0)	
Oropharyngeal Dysphagia Moderate-Severe	7 (22.6)	0 (0.0)	
Severe Oropharyngeal Dysphagia	6 (19.4)	0 (0.0)	

*Statistically significant

Table 2. Description of the type and diagnosis of the cardiopathy of the babies of the experimental group

Variables	Group Study (n=31)
Type of cardiopathy - n (%)	
Cyanotic	7 (22.6)
Acyanotic	24 (77.4)
Diagnostics - n (%) #	
Interventricular Communication	8 (25.8)
Persistence of the Arterial Canal	10 (32.3)
Pulmonary stenosis	9 (29.0)
Aortic Supravalvar Stenosis	6 (19.4)
Aortic Coaction	1 (3.2)
Transposition of Great Arteries	11 (35.5)
Atresia Tricuspid	2 (6.5)
Intracardiac Tumor	1 (3.2)
Patent foramen oval	2 (6.5)
Left Heart Hypoplasia Syndrome	3 (9.7)
Defect of the Atrioventricular Septum	1 (3.2)
Aortic arch hypoplasia	1 (3.2)
	1 (3.2)

#Overlapping responses

Table 3. Comparison of the cardiorespiratory parameters before and during feeding in the breast and in the bottle in the two groups studied

Variables	n	Before (n=31)	During (n=31)	Difference (IC 95%)	p
		Mean ± SD	Mean ± SD		
Group Study					
HR - Breast Mother	16	151.6 ± 17.5	158.9 ± 23.0	7.3 (0.1 to 14.6)	0.049*
RF - Breast Mother	16	34.8 ± 9.7	46.2 ± 15.5	11.4 (3.2 to 19.7)	0.010*
POS - Breast Mother	16	96.2 ± 3.7	93.4 ± 4.9	-2.8 (-4.2 to -1.3)	0.001*
HR - Bottle Feed	19	145.4 ± 24.2	151.0 ± 28.6	5.6 (0.2 to 11)	0.044*
RF - Bottle Feed	19	35.3 ± 9.3	40.4 ± 10.9	5.1 (1.3 to 8.9)	0.011*
POS - Bottle Feed	19	95.9 ± 4.1	93.1 ± 5.2	-2.8 (-4.3 to 1.3)	0.001*
Group Control					
HR - Breast Mother	27	109.5 ± 10.7	107.9 ± 10.6	-1.7 (-3.7 to -0.4)	0.107
RF - Breast Mother	27	33.0 ± 4.6	32.5 ± 4.5	-0.5 (-1.6 to 0.5)	0.291
POS - Breast Mother	27	98.0 ± 1.9	98.6 ± 1.5	0.6 (0.1 to 1.1)	0.029*
HR - Bottle Feed	4	109.0 ± 7.1	114.0 ± 5.7	5.0 (-7.7 to 17.7)	0.126
RF - Bottle Feed	4	31.5 ± 5.0	34.5 ± 5.0	-	-
POS - Bottle Feed	4	97.5 ± 0.7	99.5 ± 0.7	2.0 (-10.7 to 14.7)	0.295

Caption: HR: Heart Rate; RF: Respiratory Frequency; POS: Peripheral Oxygen Saturation; *Statistically significant

Table 4. Comparison of cardiorespiratory parameters during feeding with the conclusion of PAD-PED in the study group

Variables	n	Normal swallowing	Oropharyngeal Dysphagia Light	Oropharyngeal Dysphagia Moderate	Severe Oropharyngeal Dysphagia	Difference (IC 95%)	p
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
Group Study							
HR – Breast Mother	16	157.0 ± 20.8	152.3 ± 27.0	167.3 ± 11.8	166.3 ± 32.0	-	0.784
RF – Breast Mother	16	56.0 ± 13.6	45.8 ± 19.5	35.6 ± 7.5	44.3 ± 11.8	-	0.420
POS – Breast Mother	16	95.5 ± 6.4	92.3 ± 4.8	95.3 ± 2.8	91.0 ± 4.6	-	0.571
HR Bottle Feed	19	159.2 ± 24.2	132.0 ± 22.6	161.4 ± 30.9	154.5 ± 38.9	-	0.283
RF Bottle Feed	19	43.2 ± 13.9	40.0 ± 10.5	42.5 ± 10.3	28.5 ± 2.1	-	0.429
POS - Bottle Feed	19	92.5 ± 9.2	95.6 ± 1.3	91.1± 5.1	92.5 ± 2.1	-	0.558

Caption: HR: Heart Rate; RF: Respiratory Frequency; POS: Peripheral Oxygen Saturation

DISCUSSION

Cardiac alterations in children can generate a series of changes with nutritional consequences: energy expenditure, increased time to eat and risk of oropharyngeal dysphagia[8-11,14]. These variations were studied in heterogeneous groups of infants with other associated comorbidities, such as Down Syndrome[17,18] and may not be specifically associated with heart disease. However, a recent study[14] identified in isolated heart disease the presence of dysphagia, with oral and pharyngeal phase alterations.

The variation of cardiorespiratory parameters during feeding is an important factor to be studied that can clinically assist in the diagnosis of dysphagia. Studies show the influence of a POS drop during swallowing as an indicative risk factor for dysphagia[19,20]. It is also known that, as respiratory effort increases and there is a consequent increase in RF, the swallowing sequence can be modified and may be followed by inspiration or apnea, increasing the risk of aspiration[7]. This quantitative data may make clinical speech-language assessment less subjective, after establishment of baseline and expected patterns for each specific population.

In our study, the groups formed were similar in age, which made the sample uniform and possible to make comparisons. This variable influences the sucking rhythms and respiratory pauses of the patients in the diet[21]. Differences were observed between the feeding route at the time of evaluation, because the SG was a group with post-surgical heart babies, presented with an alternative feeding route at the time of evaluation (45.8%). On the other hand, the CG presented all its participants with exclusive oral route, since they are children without comorbidities. One of the main indications for the use of an alternative feeding route is the impossibility of oral feeding[22]. However, it is known that the prolonged use of gastric or enteral catheters is detrimental to the development and coordination between sucking, swallowing and breathing[23]. CC can be classified as acyanotic and cyanotic based on pulmonary circulation conditions. Cyanotic cardiopathies usually exhibit a lower basal POS[24]. In this study the majority of children had acyanotic CAD, given that they corresponded to a higher incidence of this classification of cardiopathy[25] and it

may also explain the finding of the basal POS of the SG being lower than that of the CG.

Babies with heart disease already had higher baseline RR and HR values than the CG, corroborating the literature[21], which identifies this data in heart patients as a consequence of respiratory discomfort caused by CC. We found a significant increase in the baseline (before food supply) parameters of FC and FR for the parameters during feeding in the EG, both in mother's womb and in bottle. This finding demonstrates greater effort during feeding, corroborating with data from literature that identifies this increase in RF as a risk factor for aspiration[15].

A decrease in POS was observed in SG during breastfeeding, which according to others studies, may be indicative of risk for dysphagia[20]. In the group without comorbidities, POS increased during feeding. In breastfeeding there is skin-to-skin contact with the mother, which, in addition to improving levels of coordination between sucking, breathing and swallowing, strengthens the bond between mother and baby[26,27]. There is reference in the literature[28] identifying that RF and tidal volume of oxygen decrease during feeding, in which transitory oxyhemoglobin desaturation can be observed. Pulse oximeters are calibrated to hemoglobin saturation values higher than those found in the more severe cyanotic children and therefore their accuracy will be lower in these infants[19]. However, the interpretation of the data obtained with the pulse oximeter took into account the variation of this parameter and therefore does not make the use of the measurement unfeasible.

Therefore, as described previously, variations in the cardiorespiratory parameters of these post-surgical cardiopathy infants during feeding were evidenced. There was no statistically significant difference in the variation of cardiorespiratory parameters associated with intercurrences in the clinical evaluation of swallowing (such as coughing and choking) nor with the conclusion of the swallowing evaluation, although more than 75% of the SG sample presented with dysphagia. Dysphagia presents as a difficulty in swallowing related to the functioning of one or more oropharyngeal and oesophageal structures, making it difficult or impossible for safe, effective and comfortable oral ingestion of food, which may lead to malnutrition, dehydration, aspiration, displeasure and social isolation complications such as aspiration pneumonia and death[29].

The findings of variation of cardiorespiratory parameters are associated with heart disease but no causality of dysphagia was identified for them. We emphasize that before feeding, infants were evaluated by speech therapists with experience in the area of dysphagia and with application of protocol[15] to identify the babies and select those that scored above the cutoff point for oral onset. We emphasize that the clinical condition of preterm infants is different from infants with CHD because there is an improvement in the coordination between suckling, breathing and swallowing in premature infants, according to the maturation of the central nervous system[18]. This screening application may have excluded infants with greater variations in basal cardiorespiratory parameters and consequently, the occurrence of later complications during the clinical evaluation of swallowing.

We also emphasize the uniformity of EE in this study, which excluded other risk factors for dysphagia[10] such as syndromes, neurological alterations, upper airway malformations and associated respiratory disease. This criterion allowed the findings to be exclusively assigned to the cardiopathy population since, in the relevant studies[17,18] in the area, they always presented overlaps of clinical diagnoses and underlying pathologies.

The limitations of this study were the restricted number of infants diagnosed with heart disease alone and that the infants in the CG were evaluated outside an Intensive Care Unit environment, without continuous monitoring of the cardiorespiratory parameters.

CONCLUSION

The study identified the variation of the cardiorespiratory parameters in the feeding of cardiopathy infants post cardiac surgery, showing the trend of higher HR and RF and lower POS as baseline. There was an increase in the HR, RR, and saturation drop rates during the feeding of cardiac infants compared to the group of infants without cardiac alterations.

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Author contributions

VSGM and PCS developed the project and collected the research data. CLE and LRB were guiding the study, performing statistical review, contributing in the writing of the work.