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Effect of physiotherapeutic modalities on the vital signs of tracheostomized children

Efeito de modalidades fisioterapêuticas sobre os sinais vitais de crianças traqueostomizadas

Efecto de modalidades fisioterapéuticas sobre signos vitales de niños con traqueotomía

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Objective: to assess whether the manual hyperinflation maneuver with chest compression has a better impact on stability on vital signs than vibrocompression in spontaneously breathing tracheostomized children. **Methods:** non-randomized prospective longitudinal clinical trial with children, randomized between two groups (G1) that received the hyperinflation maneuver with chest compression, and another (G2) that underwent vibrocompression. Vital signs were checked before and after 15 minutes. **Results:** 33 children participated, of which 16 in G1 and 17 in G2. The significance value (p <0.05) of peripheral oxygen saturation reached: (%) 0.105 x 0.434; heart rate 0.300 and 0.588; respiratory rate 0.763 and 0.836; systolic blood pressure 0.300 and 0.756; diastolic blood pressure 0.985 and 0.179; mean arterial pressure 0.678 and 0.459. **Conclusion:** manual hyperinflation with chest compression had better clinical repercussions; however, there was no statistical significance between groups.
Descriptors: Tracheostomy; Child; Physical therapy modalities; Vital signs.

Objetivo: avaliar se a manobra de hiperinsulflação manual com compressão torácica apresenta melhor repercussão para estabilidade sobre os sinais vitais do que a vibrocompressão em crianças traqueostomizadas em respiração espontânea. **Método**: ensaio clínico prospectivo longitudinal não randomizado com crianças, randomizadas entre dois grupos (G1) que recebeu a manobra de hiperinsulflação com compressão torácica, e outro (G2) realizado a vibrocompressão. Os sinais vitais foram verificados antes e após 15 minutos. **Resultados:** participaram 33 crianças, das quais 16 no G1 e 17 no G2. O valor de significância (p <0,05) da saturação periférica de oxigênio alcançou: (%) 0,105 x 0,434; frequência cardíaca 0,300 e 0,588; frequência respiratória 0,763 e 0,836; pressão arterial sistólica 0,300 e 0,756; pressão arterial diastólica 0,985 e 0,179; pressão arterial média 0,678 e 0,459. **Conclusão:** a hiperinsulflação manual com compressão torácica apresentou melhor repercussão clínica; entretanto, não houve significância estatística entre os grupos.
Descritores: Traqueostomia; Criança; Modalidades de fisioterapia; Sinais vitais.

Objetivo: evaluar si la maniobra de hiperinsuflación manual con compresión torácica repercute mejor en la estabilidad de los signos vitales que la vibrocompresión en niños con traqueostomía con respiración espontánea. **Método:** ensayo clínico prospectivo longitudinal no aleatorizado con niños, aleatorizados entre dos grupos (G1) que recibieron la maniobra de hiperinsuflación con compresión torácica, y otro (G2) que recibió vibrocompresión. Se verificaron los signos vitales antes y después de 15 minutos. **Resultados:** participaron 33 niños, 16 en el G1 y 17 en el G2. El valor de significación (p <0,05) de la saturación periférica de oxígeno alcanzó: (%) 0,105 x 0,434; la frecuencia cardíaca 0,300 y 0,588; la frecuencia respiratoria 0,763 y 0,836; la presión arterial sistólica 0,300 y 0,756; la presión arterial diastólica 0,985 y 0,179; la presión arterial media 0,678 y 0,459. **Conclusión**: la hiperinsuflación manual con compresión torácica presentó una mejor repercusión clínica, aunque no hubo significación estadística entre los grupos.
Descriptores: Traqueostomía; Niño. Modalidades de fisioterapia; Signos vitales.

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INTRODUCTION

Tracheostomy is an alternative for patients with respiratory failure undergoing prolonged endotracheal intubation. It is a relatively common method in adults, however, less frequent in children[1]. Described in cases of diphtheria, in the 19th century, there are several indications, from the prevention of airway obstruction, to long-term mechanical ventilation in neuromuscular diseases, congenital anomalies, obstructive sleep apnea and acquired subglottic stenosis[2].

The tracheostomy tube diverts the passage of air from the nasal and oral cavities, which protect the airways, and thus facilitates the access of microorganisms to the lower respiratory tract[3]. Tracheostomized children are at greater risk of developing infections of this order, which leads to frequent hospitalizations and higher morbidity[4]. Despite the high rate of morbidity and mortality, there are currently no widely accepted guidelines, standards or protocols for the management of tracheostomies in children[5].

The purpose of respiratory physiotherapy is to promote the elimination of tracheobronchial secretions, and thus decrease airway resistance, improve gas exchange and facilitate breathing[6]. However, there are controversies about its benefits, and research involving all areas of respiratory physiotherapy has limitations regarding the instruments used in the evaluation and clinical reproduction of the techniques[7].

Manual hyperinflation with chest compression, also known as bag-squeezing (BS), consists of a combination of manual hyperinflation, in which a manual resuscitator is used, chest compression during expiration, and then tracheal aspiration to remove the displaced secretion, simulating the cough mechanism[8]. The recommendation for hyperinflation is that inspiration be slow and deep, with an inspiratory pause followed by rapid expiration[9].

The vibrocompression maneuver promotes bronchial hygiene, associates vibration, in which rhythmic oscillatory manual movements are applied to the chest wall, and chest compression with depression of the rib cage during expiration, thus causing displacement of secretions by increasing intrapleural pressure and expiratory flow[10]. Despite their use, studies evaluating the efficacy and effects of these therapeutic modalities in spontaneously breathing tracheostomized children are scarce.

It is a resource frequently prescribed by the physician for the treatment of spontaneously breathing tracheostomized children. However, given the diversity of techniques and resources used, two maneuvers stand out in spontaneous breathing: manual hyperinflation with chest compression (more frequent) and vibrocompression; however, studies evaluating the efficacy and effects of these therapeutic modalities are scarce.

Mortality attributed to tracheostomized children is high, ranging from 13% to 19%[11], and complications range from 12.6% to 30%[12]. The performance of multidisciplinary teams in the care of tracheostomized patients has shown an effective reduction in episodes of adverse effects[13].

Thus, this study aims to evaluate whether the manual hyperinflation maneuver with chest compression has a better impact on stability on vital signs than vibrocompression in spontaneously breathing tracheostomized children.

METHODS

This is a non-randomized prospective longitudinal clinical trial carried out between November 2018 and October 2019. The sample consisted of randomly hospitalized children, composing two groups (one with manual hyperinflation with chest compression - G1, and the other with vibrocompression - G2).

Inclusion criteria were: tracheostomized children breathing spontaneously, in room air or using oxygen support in a mask, with a medical prescription for respiratory physiotherapy, and as exclusion: tracheostomized children undergoing mechanical ventilation; patients with heart disease; clinical situations in which respiratory physiotherapy was contraindicated (hemodynamic instability, fever and severe bronchospasm); children weighing less than 1.5 kg; and neuropsychomotor agitation.

The choice of patients was in order of prescription, that is, as soon as the physician indicated respiratory physiotherapy, with the acceptance of parents or legal guardians to participate in the study, signing the Term of Free and Informed Consent (TCLE).

Both groups underwent endotracheal aspiration after the procedure, and clinical and sociodemographic data were entered into a form prepared by the researchers and then transcribed into a Microsoft Excel™ spreadsheet, version 2010.

All procedures were performed according to the care and routine protocols in force at the institution. The vital signs analyzed were: peripheral oxygen saturation (SpO_2), heart rate (HR), respiratory rate (RR), systemic blood pressure (SBP) and mean arterial pressure (MAP).

To check SpO_2 and HR, a device with a digital display and pulse and oxygen sensor was used, attached to the thumb of the child's left hand, a vital signs monitoring system DX 2023 LCD- Dixtal-Biomédica™. The RR was counted by observing the abdominal or chest wall movement in and out for one minute for accurate measurement.

SBP and MAP were measured by non-invasive measurement, oscillometric method with proper cuff - vital signs monitoring system DX 2023 LCD- Dixtal-Biomédica™. The device's pressure cuff was the appropriate size for the circumference and length of the left lower limb at the height of the heart.

The device used to monitor vital signs was the DX 2023 LCD-Dixtal-Biomédica™, belonging to the pediatric ward, which remained in the sector, in the equipment room, and underwent preventive maintenance, in accordance with institutional protocols. The consultations and data collection were performed by a single professional.

In vibrocompression (G2), the child was positioned in dorsal decubitus, with the head of the bed elevated at 45°. Rhythmic and fast small-amplitude oscillatory manual movements were performed on the chest wall, in addition to compression of the chest wall during the expiratory phase of the respiratory cycle. The procedure lasted 5 minutes. The supply of oxygen (O_2) was the usual one, that is, the amount of O_2 that the subjects already used - otherwise, they remained in ambient air.

In manual hyperinflation with chest compression (G1), the child was positioned in dorsal decubitus, with the head elevated at 45°, and rhythmic manual hyperinflations were performed with the manual resuscitator attached to the O_2 flowmeter at 5 liters per minute, inspiratory flow slow, one-second pause with the manual resuscitator and a high expiratory flow alternating with manual compressions during the expiratory phase, lasting 5 minutes.

In endotracheal aspiration for both G1 and G2, the child was positioned in dorsal decubitus with the headrest elevated at 45°, with previous oxygenation, with a tracheostomy mask, coupled to the O_2 flowmeter at 5 liters per minute. The probe was introduced, closed to the point of resistance, and aspiration was performed. In the presence of thick secretion, a 0.9% saline solution was instilled into the tracheostomy tube, and then a new aspiration was performed.

Data were collected at two different times. Moment 1 (M1): immediately before the application of the technique; and Moment 2 (M2): 15 minutes after tracheal aspiration.

The variables were analyzed using descriptive and inferential statistics. Data were replicated absolutely and relatively. The inferential analysis of the statistical crossings was carried out to verify the variation of the results between the analyzed groups, aiming to know the relationship between them. One of the variables was parameterized as dependent and the other as independent, in order to analyze the prediction of both. Hypothesis tests were performed using the Kruskal-Wallis method, in which the behavior of the correlations between the analyzed variables and the degree of explanation of the dependent variable in relation to the independent variables of the sample were analyzed. The result was considered significant when p<0.05, characterizing the significance between the studied groups. All tests included an alpha error of 5% and a reliability of 95%.

All analyzes were obtained using the Software Statistical Package for Social Sciences (SPSS), version 23, linked to the functionality of the Excel™ tool (version 2016). In some moments, given the need, for a better understanding, the following were used: mean, median, mode, standard deviation, standard error, maximum value, minimum value and significance to compare the groups in the evaluations.

This research was approved by the Ethics and Research Committee of the Faculdade de Medicina de São José do Rio Preto (FAMERP), Opinion No 2,767,529, it is a by-product of the matrix research entitled: "*Educação e gestão em saúde: enfoques inter-relacionados de assistência, ensino e pesquisa*" (Education and health management: inter -related assistance, teaching and research).

RESULTS

33 children participated, 16 in G1 and 17 in G2, shown in Table 1.

Table 1. Children and percentages in relation to the intersection of sociodemographic data and division between G1 and G2. São Jose do Rio Preto, SP, 2019.

Informations	Group 1		Group 2		Total	
Age	**No**	**%**	**No**	**%**	**No**	**%**
29 days to 2 years	6	37.50	5	29.41	11	33.33
3 to 7 years	2	12.50	6	35.29	8	24.24
8 to 10 years	3	18.75	2	11.76	5	15.15
> 10 years	5	31.25	4	23.53	9	27.27
Total	**16**	**100.00**	**17**	**100.00**	**33**	**100.00**
Sex	**No**	**%**	**No**	**%**	**No**	**%**
Female	8	50.00	9	52.94	17	51.52
Male	8	50.00	8	47.06	16	48.48
Total	**16**	**100.00**	**17**	**100.00**	**33**	**100.00**
Diagnosis	**No**	**%**	**No**	**%**	**No**	**%**
Breathing problems	7	43.75	7	41.18	14	42.42
Neurological problems	2	12.50	2	11.76	4	12.12
Postoperative status	3	18.75	5	29.41	8	24.24
Metabolic problems	1	6.25	0	0.00	1	3.03
Cardiovascular problems	0	0.00	2	11.76	2	6.06
Others	3	18.75	1	5.88	4	12.12
Total	**16**	**100.00**	**17**	**100.00**	**33**	**100.00**
Background	**No**	**%**	**No**	**%**	**No**	**%**
Previously healthy child	3	18.75	1	5.88	4	12.12
Neuropathies	6	37.50	6	35.29	12	36.36
Inborn metabolic erros	1	6.25	3	17.65	4	12.12
Genetic syndromes	2	12.50	2	11.76	4	12.12
Preterm child	1	6.25	3	17.65	4	12.12
Others	3	18.75	2	11.76	5	15.15
Total	**16**	**100.00**	**17**	**100.00**	**33**	**100.00**

Table 2 shows the means separated by groups, and the p values, relative to the crossing of the variables: SpO_2, HR, RR, SBP, DBP and MBP at moments M1 and M2. The average value of oxygen saturation, at M2, showed an increase in both groups; however, in Group 1 this increase was 0.36% higher. There was a decrease in heart rate in both groups, comparatively, the drop was more pronounced in G1, at -3.62% after the intervention. The respiratory rate also showed a decrease after both interventions, -0.61% higher in G1.

Systolic blood pressure showed a reduction in the mean value in M2, after the evaluated techniques, this decrease was -2.43% more pronounced in G1. In diastolic and mean pressure, there is a decrease in mean values in G1 and G2, however, higher in Group 2, at -3.98% and -2.15%, respectively.

Both techniques proved to be safe in their application, with regard to the clinical and statistical repercussions of the parameters evaluated after their application. However, the manual hyperinflation technique with chest compression was more effective compared to vibrocompression, although the p values did not show statistical significance in M1 and M2, in any of the vital signs analyzed.

Table 2. Mean and p values, relative to the crossing of variables: SpO_2, HR, RR, SBP, DBP and MBP at moments M1 and M2. São Jose do Rio Preto, SP, 2019.

Oxygen saturation	Mean M1	Mean M2	Diference	%	p
G1	96.38	97.56	1.18	1.22	0.105
G2	96.29	97.12	0.83	0.86	0.434
Heart rate					
G1	123.88	116.81	-7.07	-5.71	0.300
G2	118.00	115.53	-2.47	-2.09	0.558
Respiratory rate					
G1	30.44	29.88	-0.6	-1.97	0.763
G2	34.35	34.82	0.47	1.36	0.835
Systolic blood pressure					
G1	121.81	115.69	-6.22	-5.11	0.300
G2	105.24	103.06	-2.18	-2.07	0.756
Diastolic blood pressure					
G1	73.31	70.88	-2.43	-3.31	0.895
G2	66.24	61.41	-4.83	-7.29	0.179
Mean blood pressure					
G1	87.25	85.31	-1.94	-2.22	0.678
G2	78.00	74.59	-3.41	-4.37	0.459

When comparing the values before and after the intervention, not differentiating which technique was used, with regard to the median values, there was a decrease in the values between M1 and M2 in all analyzed variables (SpO_2, HR, RR, SBP, DBP and MBP). There is a decrease in the standard deviation value and standard error in the SpO_2 variable, showing clinical improvement (Table 3).

With regard to heart rate, there was an increase of 1.00 in the mode value, 2.01 in the standard deviation and 0.35 in the standard error. In the respiratory rate variable, the standard deviation increased by 0.7 and the standard error by 0.12. In systolic blood pressure, there was an increase of 36.00 in the mode value. In the diastolic blood pressure variable, there was an increase of 2.00 in the mode value and in the standard deviation of 0.04. Despite this increase in relation to Moments 1 and 2, both techniques can be considered safe, as there is no statistical significance of the p values, when comparing the techniques between M1 and M2 (Table 3).

Table 3. Median, mode, standard deviation and standard error values for SpO_2, HR, RR, SBP, DBP and MBP at moments M1 and M2 for all patients. São Jose do Rio Preto, SP, 2019.

Oxygen saturation	**Median**	**Mode**	**Standard deviation**	**Standard error**
M1	96.00	96.00	2.53	0.44
M2	98.00	100.00	2.19	0.38
Heart rate				
M1	117.00	113.00	22.22	3.87
M2	114.00	114.00	24.23	4.22
Respiratory rate				
M1	28.00	23.00	12.85	2.24
M2	26.00	20.00	13.55	2.36
Systolic blood pressure				
M1	115.00	90.00	19.08	3.32
M2	111.00	126.00	17.14	2.98
Diastolic blood pressure				
M1	69.00	69.00	13.20	2.30
M2	67.00	71.00	13.24	2.30
Mean blood pressure				
M1	83.00	84.00	15.34	2.67
M2	80.00	79.00	13.00	2.26

DISCUSSION

The predominant age group in the research was from 29 days to 2 years old. The predominance of this age group is in line with a retrospective analysis, with 105 children, aged less than 16 years, who needed to undergo a tracheostomy in a children's hospital in Singapore, between 2006 and 2016, with a mean age of eight months[2].

With regard to sex, there was similarity. However, in a recent review of tracheostomized children, of the 19 studies included, 16 reported the procedure more frequently in boys, which reflects the genetic propensity or acquired diseases in males, regarding the need for tracheostomy[3].

Most of the children in this study were hospitalized for breathing problems. Through the analysis of state data from the Emergency Departments of California, Florida, Iowa and New York, a population investigation analyzed the reasons why 2,248 tracheostomized children needed to return to the hospital within a period of 30 days after discharge. This need was largely linked to respiratory complications, including respiratory failure with 11% and pneumonia with 4.0%[14].

Tracheostomy is frequent in children with multiple comorbidities[15]. Most of the children surveyed had some comorbidity that preceded hospitalization, especially neuropathies, with 36.36% (No=12). In this study, children with heart diseases were excluded.

Although usually used in clinical practice, there are few recent studies that evaluate the repercussions of the manual hyperinflation maneuver with chest compression. One publication analyzed the impacts on respiratory mechanics and vital signs of the isolated manual hyperinflation maneuver associated with chest compression and decompression of 23 adult cancer patients under invasive mechanical ventilation, with no significant benefits from the combination of techniques[16].

Regarding its use in pediatrics, described in some studies as BS, the technique has been reported as part of the physical therapy treatment strategy in premature infants with respiratory distress syndrome[17], in newborns and infants in the postoperative period of congenital heart surgery[18] and in the management of pediatric patients with COVID-19[19].

In this study, the p values related to the intersection of the variables: SpO_2, HR, RR, BP, DAP, MAP, at moments M1 and M2 did not obtain statistical significance, suggesting that despite the clinical differences observed in favor of the manual hyperinflation technique with chest compression, it is not more efficient than vibrocompression with regard to the repercussions for the stability of the vital signs evaluated.

The measurement of vital signs (SSVV) is important in the hospital routine, as it indicates the patient's health condition, its evolution or clinical deterioration[20].

The last Cochrane systematic review that evaluates the efficiency of physiotherapy with regard to the time to clinical resolution in children affected by pneumonia, brought together several studies that compared any type of intervention to no intervention. In five surveys, respiratory rate was used as a clinical parameter, another five considered SpO_2[6] levels.

Studies on respiratory physiotherapy modalities present controversial results, as they are based on obscure and multifactorial outcomes, which take into account, among others, length of stay[21]. No recent studies were found that evaluated the repercussions of manual hyperinflation with chest compression and vibrocompression regarding stability on vital signs than vibrocompression in spontaneously breathing tracheostomized children.

A study evaluated the reasons and which maneuvers were most used by 185 physiotherapists from five different hospitals, and the most mentioned were vibrocompression, hyperinflation, postural drainage, tracheal aspiration and motor mobilization, and the reason for the choice was based on the effectiveness observed in the clinical practice, without references to scientific evidence[22]. For this reason, there is a need for further investigations to serve as a basis for the use of routinely applied maneuvers.

A survey of 30 preterm newborns on mechanical ventilation sought to understand the repercussions of a physiotherapy protocol, and included: BS, slow acceleration of expiratory flow (AEF) and aspiration, on cardiopulmonary parameters; observed an improvement in SpO_2 and the HR and RR variables remained within normal limits, therefore, the protocol was considered safe[23].

Regarding vibrocompression, a study analyzed, using the Wang scale, the respiratory function of 10 children with acute viral bronchiolitis (AVB), divided into two groups, treated by conventional physiotherapy through vibrocompression and non-conventional physiotherapy, which covered the modalities of increased expiratory flow (IEF), slow and prolonged expiration (SPE) and intermittent positive pressure breathing (IPPB). The results showed efficacy in both physiotherapeutic techniques[24].

Another research compared, in 25 children, the cardiac and respiratory repercussions and the elimination of bronchial secretions, between vibrocompression and the Pulsar™ resource. The two modalities showed efficiency regarding the elimination of secretions. There were no relevant changes between HR and RR, however after vibrocompression, there was an increase in SpO_2[25].

CONCLUSION

Although manual hyperinflation with chest compression has better clinical repercussions than vibrocompression, it has not shown statistical differences that support a better efficiency of one technique over the other, with regard to the repercussions for the stability of the vital signs evaluated, which reflect on the cardiopulmonary function of tracheostomized children breathing spontaneously.

It is also noteworthy that both techniques proved to be safe, in such a way that they did not cause statistically relevant changes in the evaluated parameters after their application. Publications on the subject are scarce, requiring further randomized investigations with a larger number of patients to support the techniques.

As limiting factors, the scarcity of methodological references, the small sample size and the use of O_2 support at 5 liters per minute in G1, while children in G2 who did not make continuous use of O_2, remained in room air during care, despite prior oxygenation prior to the endotracheal aspiration procedure for all children with a tracheostomy mask, coupled to an oxygen (O_2) flowmeter at 5 liters per minute. This fact may have somehow influenced the stability of the vital signs analyzed.

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