Profile of children undergoing congenital heart surgery and analysis of their respiratory complications

Perfil das crianças submetidas à correção de cardiopatia congênita e análise das complicações respiratórias

Perfil de los niños sometidos a la corrección de cardiopatía congénita y análisis de las complicaciones respiratorias

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ABSTRACT

Objective: To describe the profile of children that undergo surgical correction of congenital heart disease (CHD) in a university hospital and to compare patients with and without postoperative respiratory complications.

Method: This observational analytical study reviewed the records of children that underwent corrective surgery for CHD a Brazilian University Hospital during 11 months. The following demographic variables were collected: age, sex, body mass index, comorbidities, and CHD types. Demographic variables and data about the intra- and postoperative care were compared for patients with and without postoperative respiratory complications. The Mann-Whitney and the Fisher exact tests were used, and the level of significance was set at $p<0.05$.

Results: The sample consisted of 55 children (49% boys) whose median age was 37.5 months. Three or more CHD were found in 29.1%, and 53% of all cases had comorbidities. The analysis of postoperative respiratory complications revealed that 31% of the patients had atelectasis and pleural effusion and 5.5% had laryngitis, pneumomediastinum or lung injury. Non-respiratory complications were identified in 24% of the patients. Survival was 89%. Children with postoperative respiratory complications received mechanical ventilation for a longer time and had a prolonged hospital stay ($p<0.001$).

Conclusion: The association between respiratory complications, longer mechanical ventilation and longer hospital stay reinforced the need to avoid such complications to reduce costs of a prolonged hospital stay.

Key-words: heart defects, congenital; thoracic surgery; clinical evolution; intensive care units; pediatrics.

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Fonte financiadora: Fundação do Desenvolvimento Administrativo (FUNDAP-SP)
Conflito de interesse: nada a declarar

Recebido em: 12/3/2011
Aprovado em: 8/8/2011

RESUMO

Objetivo: Descrever as características demográficas e clínicas de crianças submetidas à cirurgia de correção de cardiopatia congênita (CC) em um hospital universitário, comparando pacientes com e sem complicações respiratórias no pós-operatório.

Métodos: Estudo retrospectivo, realizado por meio de consulta de prontuários de crianças submetidas à cirurgia corretiva de CC em hospital universitário brasileiro no período de novembro de 2006 a setembro de 2007. Foram analisados dados relativos a idade, sexo, peso, comorbidades e tipo de CC das crianças incluídas no estudo, comparando pacientes com e sem complicações respiratórias no pós-operatório. Foram utilizados o teste de Mann-Whitney e exato de Fisher, considerando-se significante $p \leq 0,05$.

Resultados: Foram analisados 55 (95%) prontuários disponíveis de crianças submetidas à cirurgia cardíaca com mediana de idade de 37,5 meses, sendo 49% meninos. Presença de três ou mais CC foi verificada em 29,1% dos pacientes e 53% dos casos apresentavam comorbidades. Quanto às complicações respiratórias no pós-operatório, 31% dos pacientes evoluíram com atelectasia/derrame pleural e 5,5% laringite/pneumomediastino/lesão pulmonar. Complicações em outros sistemas foram identificadas em 24% dos pacientes. A sobrevida foi de 89% e crianças com complicações respiratórias no pós-operatório foram submetidas a maior tempo de ventilação mecânica e permanência hospitalar ($p<0,001$).

Conclusões: O conhecimento da relação entre complicações respiratórias e maior tempo de ventilação mecânica e hospitalização reforça a necessidade de prevenir tais complicações para redução dos custos hospitalares.

Palavras-chave: cardiopatias congênitas; cirurgia torácica; evolução clínica; unidade de terapia intensiva; pediatria.

RESUMEN

Objetivo: Describir las características demográficas y clínicas de niños sometidos a la cirugía de corrección de cardiopatía congénita (CC) en un hospital universitario, comparando pacientes con y sin complicaciones respiratorias en el post-operatorio.

Métodos: Estudio retrospectivo, realizado por medio de consulta de prontuarios de niños sometidos a la cirugía correctiva de CC, en el Hospital de Clínicas de la Universidad Estadual de Campinas (Unicamp), en el periodo de noviembre de 2006 a septiembre de 2007. Se analizaron datos relativos a la edad, sexo, peso, comorbidades y tipo de CC de los niños incluidos en el estudio, comparando pacientes con y sin complicaciones respiratorias en el post-operatorio. Se utilizaron el test de Mann-Whitney y el exacto de Fisher, considerándose significante $p \leq 0,05$.

Resultados: Se analizaron 55 (95%) prontuarios disponibles de niños sometidos a la cirugía cardíaca con mediana de edad de 37,5 meses, siendo el 49% muchachos. Presencia de tres o más CC fue verificada en el 29,1% de los pacientes y el 53% de los casos presentaban comorbidades. Respecto a las complicaciones respiratorias en el post-operatorio, el 31% de los pacientes evolucionaron con atelectasia/derrame pleural y el 5,5% laringitis/pneumomediastino/lesión pulmonar. Otros tipos de complicaciones fueron identificadas en el 24% de los pacientes. La sobrevida fue del 89% y niños con complicaciones respiratorias en el post-operatorio fueron sometidos a mayor tiempo de ventilación mecánica y permanencia hospitalaria ($p<0,001$).

Conclusiones: El conocimiento de la relación entre complicaciones respiratorias y mayor tiempo de ventilación mecánica y hospitalización refuerzan la necesidad de prevenir tales complicaciones para reducción de los costos hospitalarios.

Palabras clave: cardiopatías congénitas; cirugía torácica; evolución clínica; unidad de terapia intensiva; pediatría.

Introduction

Congenital heart disease (CHD), defined as heart malformations that occur during embryonic life, are associated, mainly, with genetic factors and chromosomal changes[1]. Their incidence is eight in each 1000 live births[2] and they have an actual or potential functional importance[3]. The most common heart diseases are interventricular and atrioventricular connections[3] and, in most cases, surgical treatment is necessary for the definitive correction of defects, whenever possible, to control symptoms and improve the quality of life of patients, as well as to prevent future dysfunction[4].

In Brazil, only 30% to 35% of the patients that require heart surgery have access to this type of treatment (either palliative or corrective). The 2004 report of the Brazilian Society of Heart Surgery showed a deficit of 65% in surgeries to correct CHD in the country[2]. Despite the

scientific advances in the area, these operations are usually complex and required specific intraoperative resources, and postoperative (PO) care requires monitoring and intensive treatment because of the frequent complications, especially pulmonary disorders[5], that may directly affect the success of the surgical intervention.

Because of the complexity of managing children with CHD, both during the operation and postoperatively, studies should be conducted about the characteristics of this population and the factors that may affect the success of pediatric heart surgery. Such knowledge is important for those professionals involved in the health care provided to these patients to prevent and reduce complications resulting from surgeries. This study described the profile of children that underwent corrective surgery due to CHD in a university hospital and compared demographic and clinical characteristics of the patients with and without postoperative respiratory complications.

Method

This retrospective study analyzed exclusively descriptive variables and the progression of children that underwent surgery to correct CHD. It analyzed data recorded in the charts of patients followed up in the Hospital de Clínicas of Universidade Estadual de Campinas (Unicamp), Brazil, and collected information from the pediatric intensive care unit (PICU) admission book. One surgery per week is performed in the university hospital where this study was conducted, depending on the availability of PICU beds. This study enrolled all children that underwent palliative or corrective CHD surgery during 11 months (November 2006 to September 2007). Children were excluded if their records were not available for review from the medical filing service.

The description of patient profile was based on the following data collected from medical charts: age, sex, weight, comorbidities and type of CHD.

Patients were divided into two groups according to presence or absence of postoperative respiratory complications diagnosed by the medical team by means of clinical examination and radiographs, such as atelectasis, pleural effusion, pneumonia, pneumomediastinum, laryngitis and/or lung injury. Respiratory complication were defined as follows: atelectasis, pleural effusion and pneumomediastinum – abnormal radiological image associated with acute respiratory symptoms; pneumonia – radiological presence of lung infiltrate recently associated with purulent tracheobronchial secretion, fever or leukocytosis; laryngitis – inspiratory stridor associated with acute respiratory distress.

Demographic data (age, sec and comorbidities) were used to compare groups with and without postoperative respiratory complications. Data about the intra- and postoperative care were also evaluated, such as extracorporeal circulation (ECC), mechanical ventilation, hospitalization and patient survival.

Data were analyzed using the SPSS 13.0 for Windows. Weight, age, ECC time, time on mechanical ventilation and hospitalization time were analyzed using descriptive statistics and expressed as medians because their distribution was not normal. The other variables were described according to frequency analysis. The existence of differences between children with and without respiratory complications was analyzed using the nonparametric Mann-Whitney and the Fisher exact tests. The Spearman correlation coefficient was calculated between time on mechanical ventilation and hospitalization time. Statistical significance was set at $p \leq 0.05$.

This study was approved by the Ethics Committee of the School of Medical Sciences of Unicamp (approval no. 957/2007).

Results

During the study, 58 children underwent surgery to correct CHD. Of these, 55 were included in the analysis. Three children were excluded because their records were not available for review in the medical filing service.

Median age of the children included in the study was 37.5 months (0.1 to 141 months), and 27 (49%) were boys. Median weight was 4,285 g, and 26 (47%) had no comorbidities. Eleven (20%) children had previous pulmonary disease, and 11 had a diagnosis of some type of neurological disorder. Three (5%) children had esophageal diseases and four (8%) of those that had heart disease were premature or undernourished.

The analysis of the clinical diagnoses of heart disease revealed a greater frequency of complex heart disease (29.1%), tetralogy of Fallot (T4F) (16.4%), interatrial connection (IAC) (16.4%), persistent arterial canal (PAC) (12.7%), patent oral foramen (9.1%), intraventricular connection (7.3%), aortic coarctation (7.3%) and associated interatrial and interventricular connection (1.7%). The group of complex heart diseases was defined based on the association of three or more different heart conditions, such as the association of T4F, interatrial connection and PAC.

Table 1 - Comparison between children with and without respiratory complications

	Minimum-maximum	Mean (SD)	Median	*p*-value
Age (months)				0,020
With complications	0,1-56,0	18,8±20,6	10,7	
Without complications	2,4-132,2	53,5±35,0	44,0	
Ventilation time (min)				<0,001
With complications	9-360	156±125	144	
Without complications	1-120	18±32	4	
Hospitalization time (hours)				<0,001
With complications	120-576	362±156	360	
Without complications	48-336	141±72	120	
ECC (min)				0,240
With complications	0-72	38±24	38	
Without complications	0-59	20±20	22	

SD: standard deviation; ECC: extracorporeal circulation

The analysis of surgery and postoperative care revealed that 35 children underwent ECC for a median time of 34 minutes (minimum, 20 min; maximum, 165 min). Patients received mechanical ventilation for a median time of 10 hours, and ventilation mode in the PICU was synchronized intermittent mandatory ventilation (SIMV) to achieve weaning and extubation as soon as possible. Median hospitalization time was 5 days for these patients. Hospitalization time varied widely, from a minimum of 24 hours for a patient with IAC to 576 hours for a child with intraventricular connection (IVC). There was a positive correlation between mechanical ventilation and hospitalization, that is, the greater the time the patient had to receive mechanical ventilation, the longer the hospitalization time (r=076; p=0.0001).

Postoperative complications were found in 53% of the patients. The most frequent was pleural effusion (8 children), followed by atelectasis (six), association between atelectasis and pleural effusion (three), laryngitis (one), pneumomediastinum and pneumothorax (one) and pulmonary injury induced by mechanical ventilation (one). There were no cases of pneumonia. Non respiratory complications, such as heart and kidney disorders, were found in 24% of the children.

Of all cases, 63% had no respiratory complications, and another 63% had no other type of non-respiratory complications. In-hospital survival was 89%, and 14% had cardiorespiratory arrest during postoperative hospital stay.

Respiratory physical therapy, whose need was evaluated during immediate PO care and whose purpose was to preserve the satisfactory conditions of pulmonary ventilation and preserve airway permeability, was conducted, whenever necessary, in 73% of the children, 25% of whom had complex heart disease, and 25%, tetralogy of Fallot.

The comparison of children with and without respiratory complications did not reveal any significant differences in sex (male; p=0.78), comorbidities (p=1.00), time required for ECC (p=0.24) and survival or death (p=1.00). Children with postoperative pulmonary complications needed a longer mechanical ventilation time (p<0.001) and were hospitalized for a longer time (p<0.01) than those without respiratory complications in the same time period. The type of heart disease was not associated with the presence of respiratory complications (Table 1).

Discussion

This study found high frequencies of complex heart disease (29.1%), followed by T4F, IAC and PAC. These data differ from those reported in a study conducted in the city of Curitiba, Brazil, which found a decreasing occurrence of ventricular septal defect (30.5%), IAC (19.1%), PAC (17%) and pulmonary valve stenosis (11.3%)[1]. Regional differences and the different demands on services may justify these divergent data. Despite these differences in the diagnostic profile of these two populations, heart diseases in our study are consistent with findings in the literature about patients admitted to university hospitals. These patients are high risk, but their treatment is facilitated because they are hospitalized in a place with a limited number of beds and in an intensive care unit only for children[6,7]. Although surgeries were not performed in very young children in our study (median age=3.1 years), undernourishment and low

weight of these patients (median weight=4285g), as well as non-cardiac comorbidities in most patients (53%), demonstrated the severity of their health condition, although all surgeries were elective.

Regardless of surgical procedure, patient conditions before the operation may define the predisposition to bronchial secretion and ventilatory complications, which may culminate in infections and atelectasis postoperatively. Moreover, there are risks resulting from the operation itself, such as the progression of pulmonary hypertension due to the readaptation of the pulmonary flow postoperatively[8,9]. Several postoperative complications are still prevalent, particularly pulmonary problems, such as pneumothorax, post-extubation edema of the glottis, diaphragm paralysis, pneumonia, respiratory distress syndrome[10], and, particularly, atelectasis[11], which corroborates the results found in our study.

Because of the high incidence of respiratory complications, physical therapy, which should be initiated on the first day after arrival in the PICU, contributes to adequate ventilation and the success of extubation[7] and reduces hospitalization time and PICU stay[12,13]. In this study, this therapy was used in 72% of the patients and may have affected the onset, or not, of respiratory complications postoperatively. A study conducted in the city of Londrina, Brazil, found that preoperative physical respiratory therapy significantly reduces the risk of pulmonary complications after pediatric heart surgery, and the most frequent complications found by those authors were pneumonia and atelectasis[14].

According to other authors, the risk factors for CHD operations are the complexity of the defect, the presence of other non-cardiac abnormalities or syndromes, age, prematurity, and hospitalization time, with the resulting increase in possible higher costs for the hospital[6]. In agreement with their findings, our study also found an association between age and the incidence of respiratory complications. However, the same was not found for previous comorbidities. For other authors, the high complexity of heart disease and the young age are risk factors of postoperative infection [15].

The analysis of the progression of the children with and without respiratory complications showed that these postoperative complications determine a longer mechanical ventilation time and hospitalization, factors that are known to affect surgical success. However, after seven days on mechanical ventilation, it is difficult to differentiate complications that are secondary to heart disease from those caused by the need to receive prolonged ventilation support[16], such as pneumonia. The different diagnoses and surgical techniques used, as well as the therapies chosen for the postoperative care, make this analysis difficult, and it is not possible to assign a causal relation to respiratory complications.

The effect of hospitalization time on the frequency of respiratory complications has been assigned to the limitations of mobility while the patient is bound to the bed and to the changes in their general clinical condition resulting from the prolonged stay in the intensive care bed[17]. These changes are more evident among pediatric patients, whose anatomic and physiological characteristics increase the deleterious effects of not moving[17]. Studies reported that prolonged mechanical ventilation is associated with longer times in the PICU and higher risk of ventilator-associated pneumonia[18]. In addition, MV for more than three days is associated with risk of extubation failure[19].

Contrary to some studies about this issue, our study did not find any association of ECC time and respiratory complications. Studies in the literature associated heart surgery ECC with the development of a series of respiratory complications, such as atelectasis and decreased functional residual capacity, which may lead to hypoxemia[20], as well as increased capillary permeability and consequent reduction of pulmonary compliance and impaired gas exchanges[6]. ECC duration is an important predictor of sequelae and complications postoperatively[21], and studies found a significant correlation between death, type of surgical correction, ECC time and myocardial ischemia[6]. However, other, preferably multicenter, studies with larger numbers of patients and including several surgery types should be conducted to compare and critically evaluate the factors that increase the risk of pulmonary complications.

A study conducted in a public university hospital for heart surgery in the northeastern region of Brazil found that hospital mortality was 17.2%[22], a value higher than the one found in our study. In international studies, Székely *et al*[16] evaluated a group of 411 children that underwent heart surgery and found a mortality rate of 3.2%. However, those authors stress that 15 of those children were transferred to other medical services and two died after hospital discharge.

As this study was based on the analysis of medical charts, it is important to draw attention to the fact that it is difficult to retrieve data because some information is not recorded and some charts are not available for review from the medical filing service, which limits data analysis. The

large number of types of CHD and surgical procedures also limited this study.

This study found a high prevalence of complex heart disease, a high number of comorbidities and an association between respiratory complications and longer mechanical ventilation and hospitalization times postoperatively. Such complications should be prevented to reduce costs associated with prolonged hospitalization. Knowing the profile of these patients and the aspects that lead to respiratory complication postoperatively provides a different and standardized approach that may be determinant for the success of interventions.

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