How to cite this article: Moraes BR, Bassi D, Santos PHM, Santos-de-Araújo AD, Matias PHVAS, Calles ACN. Neuropsychomotor development of children with congenital heart diseases. J Physiother Res. 2019;9(3):316-320. doi: 10.17267/2238-2704rpf.v9i3.2386

Original article

Journals BAHIANA
SCHOOL OF MEDICINE AND PUBLIC HEALTH

Neuropsychomotor development of children with congenital heart diseases

Desenvolvimento neuropsicomotor de crianças com cardiopatias congênitas

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RESUMO | INTRODUÇÃO: Especula-se que as cardiopatias congênitas (CC) podem afetar o desenvolvimento neuropsicomotor. No entanto, ainda se faz necessários estudos que visem avaliar esse desenvolvimento nas crianças com CC. **OBJETIVO:** Avaliar o desenvolvimento neuropsicomotor de crianças com cardiopatias congênitas. **MÉTODOS:** Estudo observacional de corte transversal, conduzido no Hospital do Coração de Alagoas (Maceió – AL, Brasil), no período de junho a outubro de 2016. Foram incluídas crianças internadas para a realização de cirurgias cardíacas eletivas no referido hospital, com idade entre 1 e 72 meses, e excluídas aquelas que apresentassem algum sinal de desconforto (dispneia, taquicardia, cianose, batimento de asa de nariz e uso da musculatura acessória), baixa capacidade para responder aos comandos verbais e/ou doenças/síndromes associadas que levassem ao atraso no desenvolvimento neuropsicomotor. O desenvolvimento neuropsicomotor (DNPM) foi avaliado por meio do teste de triagem do desenvolvimento Denver II, aplicado no momento pré-cirúrgico. **RESULTADOS:** Foram avaliadas 20 crianças, com idade entre 1-72 meses, das quais 05 foram excluídas. As 15 restantes tiveram média de idade de 16,12 (±15,56) meses, 7 meninos (46,66%) e 8 meninas (53,33%). Oitenta por cento das crianças apresentaram atraso no DNPM, sendo o domínio motor fino-adaptativo o mais comprometido, no qual as crianças realizaram apenas 48% das tarefas propostas. A maioria das crianças com o atraso, apresentavam persistência do canal arterial (41,66%), seguida de comunicação interatrial-CIA (16,66) e coexistência de Comunicação interatrial (CIA) e comunicação interventricular (16,66). **CONCLUSÃO:** Conclui-se que as crianças com CC apresentam o DNPM não compatível com a sua idade. Evidenciando a necessidade de diagnóstico e estimulação precoce das mesmas.

PALAVRAS-CHAVE: Desenvolvimento neuropsicomotor. Crianças. Cardiopatias congênitas. Habilidades motoras.

ABSTRACT | INTRODUCTION: It is speculated that congenital heart disease (CHD) can affect neuropsychomotor development. However, studies are still needed to evaluate this development in CC. **OBJECTIVE:** To evaluate the neuropsychomotor development of children with congenital heart defects. **METHODS:** A cross - sectional, observational study was conducted at the Heart Hospital of Alagoas (Maceió - AL, Brazil) from June to October 2016. Children hospitalized for elective cardiac surgeries were included in this hospital, aged 1 and 72 months, and those with any signs of discomfort (dyspnoea, tachycardia, cyanosis, nose wing beat and use of accessory muscles) were excluded, low ability to respond to verbal commands and / or associated diseases / syndromes leading to delay in neuropsychomotor development. Neuropsychomotor development (NPMD) was assessed using the Denver II developmental screening test, applied at pre-surgical time. **RESULTS:** Twenty children, aged between 1-72 months, of whom 05 were excluded were evaluated. The remaining 15 had a mean age of 16.12 (± 15.56) months, 7 boys (46.66%) and 8 girls (53.33%). Eighty percent had a delay in neuropsychomotor development, and the fine-adaptive motor domain was the most compromised, in which the children performed only 48% of the tasks proposed. Most of the children with the delay had patent ductus arteriosus (41.66%), followed by atrial septal defect (16,66) and coexistence of ASD and ventricular septal defect (16,66). **CONCLUSION:** It is concluded that children with CHD present NPMD not compatible with their age. Evidencing the need for diagnosis and early stimulation of the same.

KEYWORDS: Neuropsychomotor development. Children. Congenital heart diseases. Motor skills. Early stimulation.

Submitted 06/06/2019, Accepted 07/05/2019, Published 07/24/2019
J. Physiother. Res., Salvador, 2019 August;9(3):316-320
Doi: 10.17267/2238-2704rpf.v9i3.2386 | ISSN: 2238-2704
Designated editor: Sumaia Midlej

Introduction

The structural and/or cardiocirculatory function abnormalities present since birth is defined as congenital cardiac malformation. In most cases, they result from embryonic changes of a normal structure or incomplete or insufficient development[1]. About 97% of newborns with critical coronary disease survive up to one year of age, while 95% of newborns with noncritical coronary disease survive until age 182. With regard to live births, around 10 to every 1000 present some type of congenital heart disease, of those 1/3 with critical prognosis and requiring surgical intervention[3].

Heart diseases may be classified as cyanogenic or acyanogenic, characterized by the presence or absence of the bluish color of the skin and mucous membranes indicated by poor oxygenation or increased and/or decreased pulmonary blood flow, by obstruction of this outflow of the heart and/or blood flow mixed[4]. Among the risk factors that can greatly increase the chances of developing congenital heart disease in the child, the following stand out: genetics, advanced age of the mother, inadequate prenatal care and various infections[5].

In relation to the symptoms most commonly related to congenital heart diseases, cyanosis, fatigue, dyspnea, low weight, tachycardia and repeated respiratory infections are the most frequent; leading the child to be subjected to innumerable periods of hospitalization, daily care and routines involving medications and restrictions in general[1]. Also, due to the pathophysiology of the disease and its chronicity and severity, the child will be subjected to numerous hospitalizations, repetitions of exams, physical restrictions, withdrawal from school and living with other children, decreased quality of life, and delays in the development[6-9].

Neuropsychomotor development (NPMD) is considered the sequence of processes that evolve with the chronological age of the human being, initiated with simple and disorganized movements to the execution of highly organized and complex motor skills. In this context, it is characterized by the motor, cognitive and language learning obtained through the maturation of the nervous system, and are ordered through experiences experienced by the child[10].

Since an adequate NPMD is essential to provide a better functionality for the child, it was necessary to investigate the possible delay in this development of children with heart disease, since these diseases may interfere in the child's life. Therefore, the present study aimed to evaluate the NPMD of children with congenital heart diseases.

Methods

This is a cross-sectional observational study, carried out at the Hospital do Coração de Alagoas with children with congenital heart disease, from June to October 2016, after approval of the project by the Research Ethics Committee of the Tiradentes Universitary Center (opinion number 56788916.4.0000.5641), according to the Helsinki International Declaration. In accordance with Brazilian and international standards, parents or guardians of children were informed about the procedures to be performed and signed a free and informed consent form to participate in this study.

In the present study, children hospitalized for elective surgeries at the Hospital do Coração de Alagoas, aged between 1 and 72 months, were included. We excluded all those who showed some signs of respiratory discomfort (dyspnea, tachycardia, cyanosis, nose wing beat and accessory muscle use), not understanding and/or not very collaborative to respond to verbal commands given and associated diseases or syndromes to the NPMD.

The study sample was for convenience. The children were evaluated at pre-surgical time. The following data were recorded in the children's charts: gender, age, weight, height and body mass index (BMI), type of surgical correction to be performed, chronological and corrected age of premature infants. The evaluation of NPMD was applied in a reserved room of the hospital by the Denver II development screening test, which is a simple standardized method validated for Brazilian children by Drachler et al.[11].

The evaluations were performed by a single examiner with previous training in the instrument, using the original kit. The test aims to detect delays in infant DNPM in asymptomatic children, and is used as a comparison to determine how a child compares to other children. The instrument consists of 125

items, divided into: a) social-personal: aspects of the socialization of the child inside and outside the family environment; b) fine-adaptive motricity: eye-hand coordination, manipulation of small objects, body notion and reproduction of drawings; c) language: sound production, ability to recognize, understand and use language; d) broad motricity: body motor control, static and dynamic balance, sitting, walking, jumping and other movements performed through the large musculature[12]. The children submitted to the test were evaluated according to their corrected chronological age, arranged in months.

For further descriptive statistical analysis of the results, the information collected was stored in a database created from Microsoft Excel 2010 software (Redmond, WA, USA). Continuous variables were presented as mean and standard deviation (SD), while categorical variables were presented as relative and absolute frequency.

Results

Twenty children were evaluated, of which 5 were excluded because they presented another associated disease. The remaining 15 children had a mean age of 16.12 months (± 15.56), 7 males (46.66%) and 8 females (53.33%). All children had congenital acyanogenic heart diseases.

According to Table 1, which shows the absolute and relative distribution of children with NPMD delay according to the Denver II domains, most of the children evaluated did not demonstrate NPMD compatible with their age, i.e, 12 (80%) were delayed and only 3 (20%) presented normal development.

When considering the domains of the Denver II test, the children performed on average 54.44% of the tasks assessed in the personal-social domain, 48% of the tasks in the fine-adaptive motor domain, 61.92% of the tasks related to language and 71 % of tasks in the gross motor domain.

Table 1. Heart disease and delay of neuropsychomotor development by Denver II test domain

Heart disease	Total children (n=12)	Personal-social domain	Fine-adaptive motor domain	Language domain	Gross motor domain
PDA	5 (41,66)	3 (20)	4 (26,66)	3 (20)	2 (13,33)
VSD	1 (8,33)	1 (6,67)	0	0	0
ASD	2 (16,66)	1 (6,67)	2 (13,33)	0	0
ASD + VSD	2 (16,66)	1 (6,67)	1 (6,67)	0	1 (6,67)
ASD + VSD + PDA	1 (8,33)	0	0	1 (6,67)	1 (6,67)
ASD + PDA	1 (8,33)	1 (6,67)	1 (6,67)	1 (6,67)	0

Data described in n (%). PDA: patent ductus arteriosus; VSD: ventricular septal defect; ASD: atrial septal defect.

Discussion

The main findings of this study show that i) the majority of children evaluated did not demonstrate NPMD compatible with their age, ii) the greatest delay in activities was seen in the fine-adaptive motor domain.

In this context, the literature is very assertive in describing that children with congenital heart disease present a risk of motor development delays interrelated with innumerable factors, such as: physical incapacity, prolonged effects of pathology and socioeconomic conditions. However, in spite of significant advances in the hospital that allow greater survival of this population and better quality of life, deficits in development are often pointed out as one of the most common problems in these children[13-15].

The literature is consistent in stating that acyanotic congenital heart diseases are among the most common[9,16], corroborating the findings of the present study, since all the children had acyanogenic cardiopathies. Stieh et al. conducted a study

to evaluate whether children with acyanogenic congenital heart disease had disorders in fine and gross motor development before and after palliative care or corrective cardiac surgeries, and concluded that children with aciagonenic heart disease had normal motor development when compared to those with cardiogenic heart disease. But, such deficits in fine motor development were present before corrective surgery, they state that after two years the development of these children reached values close to normal values[17].

In the present study, we can't be as blunt as this statement, since the sample was composed entirely of children with acyanogenic heart diseases and also a follow-up was not performed. On the other hand, later studies demonstrate that deficiencies in motor skills of this nature are present in both populations, evidencing that, independent of the cardiopathy these children present delay in NPMD[6,18,19]. In this sense, such studies reinforce the findings of the present research, since, although, all the children with heart diseases that composed the sample were acyanogenic and yet, they presented NPMD incompatible with the biological age.

In addition to the influence of pathology on motor development retardation, the overprotection of parents with perception of child's fragility with the disease, physical inactivity, absence of external stimuli, socialization with other children and socioeconomic status are a negative contribution in the development of the individual, considering that perceptual and motor experiences impact not only on the acquisition of motor skills but also on the emotional, psychosocial and cognitive aspects[18,20].

Thus, Marino et al. suggest that periodic monitoring of development, screening, evaluation and reevaluation throughout childhood culminates in a better identification of significant deficits, aiming at targeting appropriate interventions and therapies with potential for prevention and reduction of long-term problems[21].

Finally, reinforcing the study conducted by Marino et al.[21], recommendations of early stimulation with a combination of multidisciplinary approaches should be suggested since it has a potential influence on the development of these children that may present, after the appropriate stimulation process, the appropriate development against the organization of neuronal plasticity[14,19].

The present study presents limitations that must be considered. The hospitalization time of the children was not considered in the present study. The age range of the children included in the study was extensive (1 to 72 months), a fact that may have influenced the results found. Finally, the fact that the sample is composed only of acyanotic congenital heart diseases, we suggest that future studies evaluate and additionally follow up these children, both with acyogenic and cytogenetic congenital heart diseases.

Conclusion

Considering the findings of the present study, we can conclude that children with acyanogenic congenital heart defects present NPMD not compatible with their biological age, especially in the fine-adaptive motor domain, a fact that deserves to be studied in the future. In view of the above, it is clear the need for evaluation and early stimulation in these children. In addition to systematic and longitudinal follow-up.

Author contributions

Moraes BR participated in the project design, data analysis and interpretation, article writing, critical review of intellectual content. Bassi D participated in the interpretation of data and critical analysis of the content, writing of the article, critical review of intellectual content. Santos PHM participated in the conception of the project, analysis and interpretation of the data and in the writing of the article, critical review of the intellectual content. Araújo ADS participated in the writing of the article, critical review of intellectual content. Calles ACN participated in project design, data analysis and interpretation, article writing, critical content analysis, critical review of intellectual content. Matias PHVAS participated in the project design, data analysis and interpretation, article writing, critical content analysis.

Competing interests

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

References

1. Sun R, Liu M, Lu L, Zheng Y, Zhang P. Congenital Heart Disease: Causes, Diagnosis, Symptoms, and Treatments. Cell Biochem Biophys. 2015;72(3):857-860. doi: 10.1007/s12013-015-0551-6

2. Cara TM, Tiiffany R, Alissa O, Janet DC, Richard SO, Angela L et al. Selected birth defects data from population-based birth defects surveillance programs in the United States, 2005-2009: Featuring critical congenital heart defects targeted for pulse oximetry screening. Birth Defects Research Part A Clin Mol Teratol. 2012;94(12):970-983. doi: 10.1002/bdra.23098

3. Amorim LFP, Pires CAB, Lana AMA, Campos AS, Aguiar RALP, Tiburcio JD et al. Presentation of congenital heart disease diagnosed at birth: analysis of 29,770 newborn infants. J Pediatr. 2008;84(1):83-90. doi: 10.1590/S0021-75572008000100014

4. Franklin RCG, Béland MJ, Colan SD, Walters HL, Aiello VD, Anderson RH et al. Nomenclature for congenital and paediatric cardiac disease: the International Paediatric and Congenital Cardiac Code (IPCCC) and the Eleventh Iteration of the International Classification of Diseases (ICD-11). Cardiol Young. 2017;27(10):1872-1938. doi: 10.1017/S1047951117002244

5. Abqari S, Gupta A, Shahab T, Rabbani MU, Ali SM, Firdaus U. Profile and risk factors for congenital heart defects: A study in a tertiary care hospital. Ann Pediatric Cardiol. 2016;9(3):216-22. doi: 10.4103%2F0974-2069.189119

6. Mackie AS, Tran DT, Marelli AJ, Kaul P. Cost of Congenital Heart Disease Hospitalizations in Canada: A Population-Based Study. Can J Cardiol. 2017;33(6):792-798. doi: 10.1016/j.cjca.2017.01.024

7. O'Brien P, Evangelista JA, Green A, Uzark K. Health considerations for children with congenital heart disease in school: part 1. NASN Sch Nurse. 2012;27(6):324-328. doi: 10.1177/1942602X12450738

8. Sertçelik T, Alkan F, Sapmaz SY, Coşkun S, Eser E. Life quality of children with congenital heart diseases. Turk Pediatri Ars. 2018;53(2):78-86. doi: 10.5152%2FTurkPediatriArs.2018.6428

9. Mari AM, Cascudo MM, Alchieri JC. Congenital Heart Disease and Impacts on Child Development. Braz J Cardiovasc Surg. 2016;31(1):31-37. doi: 10.5935/1678-9741.20160001

10. Dornelas LF, Duarte NMC, Magalhães LC. Neuropsychomotor developmental delay: conceptual map, term definitions, uses and limitations. Rev Paul Pediatr. 2015;33(1):88-103. doi: 10.1016/j.rpped.2014.04.009

11. Drachler ML, Marshall T, Leite JCC. A continuous-scale measure of child development for population-based epidemiological surveys: a preliminary study using Item Response Theory for the Denver Test. Paediatr Perinat Epidemiol. 2007;21(2):138-153. doi: 10.1111/j.1365-3016.2007.00787.x

12. Santos RS, Araújo APQC, Porto MAS. Diagnóstico precoce de anormalidades no desenvolvimento em prematuros: instrumentos de avaliação. Jornal de Pediatria. 2008;84(4):289-299. doi: 10.1590/S0021-75572008000400003

13. Sabates AL, Marcondes ET. Avaliação do crescimento e desenvolvimento de lactentes portadores de cardiopatias congênitas – um estudo descritivo. Online Braz J Nurs. 2006;5(2):1-8.

14. Mussatto KA1, Hoffmann RG, Hoffman GM, Tweddell JS, Bear L, Cao Y et al. Risk and Prevalence of Developmental Delay in Young Children With Congenital Heart Disease. Pediatrics. 2014;133(3):e570-e577. doi: 10.1542/peds.2013-2309

15. Leal LS, Silva RLM, Aita KMSC, Monteiro RPA, Montalvão TC. Assessment of motor development of children with congenital heart disease. Int J Cardiovasc Sci. 2016;29(2):103-109. doi: 10.5935/2359-4802.20160017

16. Daniel B. Cardiopatia Congênita. Arq Bras Cardiol. 2009;93(6 supl 1):e110-e118. doi: 10.1590/S0066-782X2009001300008

17. Stieh J, Krammer HH, Harding P, Fischer G. Gross and fine motor development is impaired in children with cyanotic congenital heart disease. Neuropediatrics. 1999;30(2):77-82. doi: 10.1055/s-2007-973464

18. Bjarnason-Wehrens B, Dordel S, Schickendantz S, Krumm C, Bott D, Sreeram N et al. Motor development in children with congenital cardiac diseases compared to their healthy peers. Cardiol Young. 2007;17(5):487-498. doi: 10.1017/S1047951107001023

19. Cruz AKT, Vasconcelos TB, Nogueira ANC, Bastos VPD, Farias MSQ. Avaliação do Desempenho Motor de Crianças Cardiopatas em Um Hospital Público no Município de Fortaleza-CE. Rev Fisioter S Fun. 2013;2(1):14-20.

20. Romano BW. Abordagem psicológica da criança cardiopata. In: Romano BW. Psicologia e Cardiologia: encontros possíveis. São Paulo: Editora Casa do Psicólogo; 2001.

21. Marino BS, Lipkin PH, Newburger JW, Peacock G, Gerdes M, Gaynor JW et al. Neurodevelopmental outcomes in children with congenital heart disease: evaluation and management: a scientific statement from the American Heart Association. Circulation. 2012;126(9):1143-1172. doi: 10.1161/CIR.0b013e318265ee8a