Cardiac Autonomic Modulation in Tetralogy of Fallot

Ana M. D. S. Antônio¹ MSc, Diego L. China² MSc, Renan Shida² MSc, Juliana C. Barbosa¹ MSc, Viviani Barnabé PhD, Luiz Carlos de Abreu⁴ MD, Vitor E. Valenti*¹ MD

Abstract
Studies have shown that patients with tetralogy of Fallot present impaired heart function. Such changes in cardiac system remain several years after the surgery, and could be related to markers of sustained ventricular tachycardia and sudden death. Herein, we aimed to describe the cardiac autonomic regulation in tetralogy of Fallot. To perform the review the articles used in this study were selected in Pubmed, Medline, Lilacs and SciELO. For this search we crossed the following keywords: tetralogy of Fallot, autonomic nervous system, reconstructive surgery, heart rate variability, which were defined based on descriptors of health Headings (MeSH). We found that, in general, patients with operated tetralogy of Fallot have changes in cardiac autonomic modulation after several years elapsed from reconstructive surgery, and they presented higher activation of the sympathetic ANS which can be associated ventricular arrhythmias. In conclusion, we observed that the patients have a reduced heart rate variability years after the correction surgery.

Keywords - Tetralogy of Fallot; Autonomic nervous system; cardiovascular system.

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From ¹Center for the Study of Nervous System (CESNA), Graduate Program in Physical Therapy, Faculty of Technology Sciences, UNESP, Presidente Prudente, SP, Brazil. ²Graduate Program in Cardiorespiratory Physiotherapy, University of Marília, UNIMAR, Marília, SP, Brazil. ³Department of Environmental Health, Harvard Medical School of Public Health, Boston, MA, EUA. ⁴Department of Morphology and Physiology, Faculty of Medicine of ABC, Santo André, SP, Brazil.
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*Corresponding Author: vitor.valenti@marilia.unesp.br
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I. INTRODUCTION
Tetralogy of Fallot is a cyanotic heart defect. The main cause of late death is sudden cardiac death, usually caused by ventricular tachycardia, pulmonary regurgitation and right ventricular dilatation. The reconstructive surgery aims to rebuild the track from the aorta and the pulmonary stenosis and fixes the defect of the interventricular canal.

Currently, there is an expectation of good surgical outcomes in patients undergoing repair of tetralogy of Fallot with the evolution of surgical techniques and intensive care postoperatively, with the possibility of correction in early life. After surgery of repair tetralogy of Fallot the chance of survival is 94%. However, these patients have compromised the effectiveness and functionality of the heart.

In this sense, the autonomic nervous system (ANS) plays an indispensable role in the regulation of physiological processes in the human body during normal and pathological conditions. Among the techniques used in its evaluation, the heart rate variability (HRV) has emerged as a simple and noninvasive measure of autonomic impulses. HRV describes the oscillations in the interval between consecutive heart beats (RR interval), as well as oscillations between instantaneous heart rates consecutives. Low HRV in patients with heart disease is a strong predictor of ventricular arrhythmias and sudden death. Furthermore, there is a strong correlation between the reduced HRV and sudden death after myocardial infarction. Impaired autonomic function may be relevant to the increased incidence of sudden death after repair of tetralogy of Fallot.

Given the importance of identifying changes induced by surgical repair of tetralogy of Fallot on the autonomic nervous system, we sought to bring together studies that addressed the analysis HRV in individuals who had surgical repair of tetralogy of Fallot to better understand the cardiac autonomic regulation in this population, and to provide an update of the findings published concerning this topic. Thus, we aimed to describe the cardiac autonomic regulation in tetralogy of Fallot.

II. METHODS
The articles used in this study were selected in Pubmed, Medline, Lilacs and SciELO. For this search we crossed the following keywords: Tetralogy of Fallot, autonomic nervous system, reconstructive surgery, heart rate variability, which
were defined based on descriptors of health Headings (MeSH). The studies were selected based on their titles and were analyzed by a single researcher, selected according to the inclusion criteria established for this review. For this, the title should expressed focus on the study: heart rate variability in patients with tetralogy of Fallot corrected autonomic control after surgical repair of tetralogy of Fallot, correlation between heart rate variability and ventricular tachycardia. After that, it was made a filtering of the results to identify repetitions, as was done in the search various databases. All titles chosen had their abstracts studied in order to select the articles that addressed cardiac autonomic regulation in patients with tetralogy of Fallot corrected. Abstracts that approached this theme had their full texts read. The selected studies had their references analyzed to identify relevant studies that were not found in the electronic search.

Studies published between the period 2000-2014, in Portuguese, Spanish, and English, who had made the correction of tetralogy of Fallot, and analyzed the autonomic nervous system with HRV were included, and all were included types of study design. For the assessment of the methodological quality of the studies PEDro scale was used. Data were qualitatively described and tabulated according to the authors and year of the study population characteristics, purpose of the study, observed index and conclusions observed.

III. RESULTS

A. Search and selection strategy

Through the use of descriptors in the search of the databases 91 references were found. The first selection resulted in the elimination of 69 titles, and the remaining studies passed to the next stage of selection, which analyzed the content of their abstracts and eliminated 14 abstracts, which did not meet the established criteria. The remaining eight texts were read. The elimination process excluded a total of 83 studies and we considered 8 manuscripts for this review.

B. Characteristics of selected studies

These data are summarized in Table I, organized by authors and year of publication, population characteristics, objectives, indices evaluated and conclusions, contain eight articles resulting from the systematic search.

IV. DISCUSSION

The aim of this study was to describe studies related to cardiac autonomic regulation in tetralogy of Fallot. The selected texts analyzed showed that in adult patients, which made surgical repair of tetralogy of Fallot presented reduced HRV11-15, we believe that this fact may be associated with hemodynamic alterations. Patients after surgical repair of tetralogy of Fallot still have a significant incidence of serious ventricular arrhythmias that can be identified through the analysis of HRV. Several factors induce changes in sympathetic and vagal modulation in postoperative patients, the surgical incision may involve the autonomic fibers, causing a heterogeneous distribution of the efferent signal to the myocardium. Moreover, the reduction in cardiac output may lead to an increase in sympathetic activity by baroreflex activation and alter ventricular kinematics14. Daliento and coworkers15 verified reduction of SDNN index compared with the control group, and a positive correlation between myocardial scintigraphy and the value of SDNN index, reflecting sympathetic predominance in operated individuals. In this context, significantly reduced value of SDNN in patients with ventricular arrhythmias found in their study suggests an influence of the activity of the autonomic nervous system on ventricular electrical instability.

Davos et al14 found in some patients an overall impairment of cardiac autonomic modulation few years after repair of tetralogy of Fallot. The patients investigated showed reduced HRV and baroreflex sensitivity. Both indices in the time (SDNN and RMSSD), and frequency domain (LF and HF) were reduced compared to the healthy control group, clearly indicating the difference in HRV. In patients who had undergone surgical correction, there was reduction of HRV because of sinus node dysfunction HRV, which is very frequent in patients with congenital heart disease. Furthermore, it was also observed an increased sympathetic tone on the hart, regardless of the value of the heart rate, which reflects the lowest values of SDNN 14.

McLeod and collaborators 16 reported a reduction in parasympathetic index (pNN50) associated with ventricular dilation and right ventricular hypertension in young, ten years after correction of tetralogy of Fallot. In this circumstance, Lammers et al. 17 found a significant increase in all parameters of HRV (SDNN, RMSSD, pNN50) and identified the SDNN index as the best predictor variable, confirming the low HRV in these patients. The LF component of spectral analysis, which indicates the sympathetic and parasympathetic modulation (with sympathetic predominance), was also associated with an increased likelihood of hemodynamic and surgical complications.

Heragu et al.18 found an association between the LF component and the probability of having hemodynamic and surgical complications i.e., the higher the value of the LF index, the lower the possibility of negative event. The increased sympathetic modulation may represent an important compensatory mechanism for heart failure associated with a reduced adrenergic discharge the neural sinus mode. Other studies have found that the values of LF were associated with reduced degree of heart failure in patients with congenital heart diseases in adults, proving to be an important independent predictor of sudden cardiac death in adults with impaired cardiac 19. On the other hand, Butera et al12 noted that the HRV indices were identical in both the preoperative group with tetralogy of Fallot and post-operative group of other congenital heart disease, but were significantly reduced in patients with tetralogy of Fallot. In the group of patients with tetralogy of Fallot indices of HRV (SDNN, RMSSD, pNN50, HF) were significantly lower in patients with non-sustained ventricular tachycardia compared with those without arrhythmias, characterized by a reduction in vagal modulation. Kaltman et al 20 investigated newborns and found impairment of cardiac autonomic control, which may be associated with prolonged hospital stays, and found a negative correlation between SDNN, and LF RMSSD indices with the time in hospital.
A previous study analyzed HRV in children with pre-school age and found no signs of cardiac autonomic dysfunction. Aletti et al. evaluated HRV in children with congenital heart disease, taking into account the effects of cyanotic and acyanotic defects. The analysis showed that the values of LF were significantly higher in children with pathological condition compared to the control group, regardless of cyanosis. These results suggested that children with congenital heart disease may have lower HRV featured by sympathetic hyperactivity and hemodynamic changes.

Another study found significant associations between HRV and presence of morbidity and mortality in children and adolescents undergoing surgical correction of congenital heart disease. The authors observed imbalance of sympathetic and parasympathetic modulation (LF / HF), the sympathetic regulation appeared more active in relation to the parasympathetic and this behavior persisted three months after hospital discharge. The reduction of cardiac parasympathetic modulation has also been demonstrated by other reduction ratios. Three months after discharge, the RMSSD, pNN50 and HF indices were reduced compared to preoperative period. The literature has shown that physical exercise promotes improvements in ANS modulation. However, other studies have shown that physical exercise is recommended for improving and maintaining cardiovascular health. The exercise therapy is a non-pharmacological treatment that improves cardiovascular fitness, quality of life, and controls autonomic reflexes in patients with heart disease crônica. Wyller et al. found after three months of exercise training significant changes in HRV parameters, decrease LF and LF / HF ratio and HF increased in the group with chronic heart failure as compared to group control. When practiced in a planned and regular physical exercise boosts the parasympathetic tone and reduces sympathetic tone improves HRV in patients with cardiac failure.

We found no studies that evaluated the HRV after an intervention of regular physical exercise protocol, but some studies have found that despite the low exercise tolerance, these patients have improved quality of life and clinical condition. Dua et al., in their prospective study concluded that the practice of simple physical activity such as walking regularly is important, safe and significantly increases exercise capacity of adult patients at all stages of congenital heart disease. It is also useful to improve the quality of life by improving physical self-perception, life satisfaction, levels of physical activity and overall health. Buys et al. investigated the level of physical activity of 73 adults with tetralogy of Fallot and concluded that inactivity contributes significantly to the reduction in exercise capacity, and can worsen heart condition these patients. Silvilarait in their study found a significant correlation between HRV and physical exercise capacity which was assessed by peak oxygen uptake in 30 patients with TOF, and found that the reduction in HRV associated with left ventricular dysfunction are contributing factors for exercise intolerance in these patients. Additional studies investigating physical exercise training for patients with tetralogy of Fallot is necessary.

We found no studies that assessed HRV after an intervention of a physical exercise protocol. In patients with tetralogy of Fallot corrected conducting studies on the influence of physical training on the SNA these patients is required.

V. CONCLUDING REMARKS

In this review we present important data on cardiac autonomic regulation in tetralogy of Fallot. It was observed that even years after the correction surgery patients have impaired HRV. We found no studies that evaluated HRV after an intervention of a physical exercise protocol. In patients with tetralogy of Fallot corrected conducting studies on the influence of physical training on the SNA these patients is required.

References


Vitor E. Valenti has completed his Ph.D at the age of 27 years from Universidade Federal de São Paulo (UNIFESP), São Paulo, SP, Brazil, he spent 5 months of his doctoral fellowship at the School of Medicine of the University of Utah, Salt Lake City, Utah, USA, and postdoctoral studies from University of São Paulo (USP), São Paulo, SP, Brazil. He has published more than 100 papers in reputed journals and serving as an editorial board member of the African Journal of Pharmacy and Pharmacology, Clinical Reviews and Opinion, Asian Journal of Medical Science, Journal of Diabetes and Endocrinology and Journal of Medical Laboratory and Diagnosis. Currently, he is associate professor at the Faculty of Philosophy and Sciences, UNESP, Marília, SP, Brazil.