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THE ROLE OF POST-OPERATIVE PHYSICAL THERAPY IN CHILDREN AND ADOLESCENTS WITH CONGENITAL HEART DISEASES

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ABSTRACT

Introduction: Congenital heart diseases (CHDs) are characterized by a structural defect of the heart, which occurs during the prenatal period or at birth. In their most complex forms, are required heart interventions such as open-heart surgery. It's a condition which pediatric patients experience respiratory problems, delayed growth and pain patterns, reduced strength and endurance, and often adopt a sedentary lifestyle. ***Purpose:*** The purpose of this research is to study the effect of a physiotherapy program during cardiac rehabilitation of pediatric patients with CHDs who have undergone surgery. ***Methodology:*** An extensive search was carried out in electronic databases, such as Google Scholar, Pupmed, PEDro, but also in medical literature. Researches, studies and writings were searched, both in Greek and English, with key words such as: congenital heart diseases, postoperative rehabilitation, physical therapy, exercise. The search was limited to studies published from 2005 onwards. ***Conclusion:*** Physiotherapy intervention enhances the postoperative rehabilitation of patients and aims to improve the prevention and recovery of patients from pulmonary complications, to limit harmful effects due to surgery or strict bed rest, and in general to improve the overall quality of life.

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INTRODUCTION

Congenital heart defects, known as Congenital Heart Diseases (CHDs), are defects in the structure of the heart that appear during the development of the heart in fetuses and newborns. These defects can occur in the inner wall of the heart and may include the septum between the atria and ventricles, the valves within the heart, or the large arteries and veins (Hofman *et al*., 2002). It is one of the most frequently diagnosed congenital disorders affecting approximately 0.8-1.2% of live births worldwide Bouma (Bouma *et al*., 2017). About 150 million live births are recorded each year, and of these, 1.35 million infants are diagnosed with CHD (Van der Linde *et al*., 2011, Marelli *et al*., 2014). Although the etiology of CHD is largely unknown, numerous studies have suggested that it is multifactorial, with both genetic and environmental factors contributing to its development (Zhang *et al*., 2022). CHD vary in their expressiveness and range from asymptomatic to life-threatening depending on the type and severity of the heart damage. Some of the symptoms can be shortness of breath, fatigue, dizziness, low weight, frequent respiratory infections, arrhythmia, cyanosis, heart murmur and developmental problems of the limbs (Sun *et al*., 2015). Some forms of CHD are treated without special treatment and without complicated procedures. Severe forms of these diseases require heart interventions such as surgery, and more specifically open heart surgery, or in rare cases heart transplantation (Triedman *et al*., 2016, Sun *et al*., 2015). Physiotherapy techniques applied to children are similar to those of adults, but due to the changes in the structure and function of the respiratory system during the development of a child, a continuous adjustment is required in the way of applying these techniques based on the age of the patient (Oberwaldner *et al*., 2000). Bronchial drainage techniques, with specific positions, vibrations, pressures, autogenous drainage, coughing, etc., help to clean the lungs. In terms of achieving full range of motion, mild exercises and posture correction are mainly used (Hristara-Papadopoulou *et al*., 2014). Massage is another technique that can be applied, with the aim of analgesia, strengthening the immune system, and relaxation and better blood supply to the respiratory muscles. In the postoperative phase, and after the child's complete recovery, the level of his motor development is evaluated and a similar program is created, based on

the child's needs (Hristara-Papadopoulou *et al*., 2014, Opocher *et al*., 2005).

MATERIALS AND METHODS

A systematic review of the existing literature was conducted regarding the effect of rehabilitation programs, specifically physical therapy, in children with CHD who have undergone surgery. An extensive search was carried out in electronic databases such as Google Scholar, PubMed, PEDro, as well as in medical literature, with included bibliographic references published from 2002 onwards. Some of the keywords used, alone or in combination, were: congenital heart disease, postoperative rehabilitation, physical therapy, exercise. Researches, studies and writings were searched, both in Greek and English, in order to display articles related to the topic of the research.

Analysis of Studies: This research included 10 articles (systematic reviews, meta-analysis, randomized, controlled intervention study, prospective study, prospective, randomized controlled trial, randomized clinical trial). The following are the main research findings included in this review. Opocher and colleagues 2005, evaluated the effect of planned exercise on the aerobic capacity of children after Fontan surgery. The exercise program (duration 8 months) involved children who had undergone the Fontan operation (7 to 12 years). The authors observed a significant increase in maximal oxygen consumption and maximal oxygen uptake (VO2 max), a decrease in heart rate curve, and an increase in oxygen pulse curve during submaximal exercise. Research results showed that patients who have undergone the Fontan procedure can safely exercise, resulting in improved aerobic capacity. Therefore, aerobic exercise could be useful in the long-term management of these patients in order to optimize their cardiovascular capacity for a more active life. Brassard *et al*., 2006, published a systematic review on exercise capacity and studied the impact of exercise in children and adolescents after the Fontan procedure. The researchers concluded that exercise had a beneficial effect on several parameters related to exercise tolerance and consequently the lives of the patients. They report that until recently, the explanation for reduced exercise capacity in patients after a Fontan procedure was attributed to limited cardiorespiratory function, however, it is already known that in patients with heart failure, skeletal muscle function is another important component of tolerance. in exercise, and when this is limited, it possibly explains the reduced exercise performance of patients after a Fontan procedure.

Dulfer *et al*., 2014, evaluated the effects of an exercise program on health-related quality of life in children and adolescents with tetralogy of Fallot or Fontan circulation. The randomized controlled intervention study conducted included 93 patients, aged 10-25 years, undergoing surgical repair for tetralogy of Fallot or Fontan circulation for single ventricle physiology. Patients were randomly assigned to two groups, with the first participating in a 12-week exercise program 3 times per week and the second being a control group. It was observed that children in the exercise group, aged 10-15 years, improved significantly in self-reported cognitive functioning and parent-reported social functioning, relative to the control group. The quality of life of patients aged 16-25 showed no significant change. Cardiac diagnosis had no effect on changes in patients' quality of life before and after the program. But more generally, it seems that participation in an exercise program improved the quality of life of children with tetralogy of Fallot or Fontan circulation compared to the control group, especially in those with low initial quality of life. Gomes-Neto *et al*., 2015, in their systematic review with meta-analysis, examined the effects of exercise on aerobic capacity and lung function in children and adolescents after surgery for CHD. Improvement in VO2max was observed, but in terms of forced expiratory flow and forced vital capacity, the improvement was not significant. In conclusion, exercise can improve VO2max in children and adolescents after tetralogy surgery and should therefore be considered for inclusion as a non-pharmacological treatment in cardiac rehabilitation programs. However, it is important to carry out further larger randomized controlled trials, which will investigate different types of exercise and its effects on patients' quality of life. Jacobsen *et al*., 2016, studied the impact of a home-based exercise cardiac rehabilitation program in children with Fontan circulation. A total of 14 children, 8 to 12 years old, with Fontan circulation participated in this program. The home program lasted 12 weeks and included both dynamic and static moderate/high intensity exercises. After the program ended, a significant improvement in the children's overall quality of life was reported by the parents, but not by the patients themselves. An improvement in physical functioning, school functioning and psychosocial functioning was also observed, while no side effects were reported. According to this study, a 12-week home-based exercise program is safe and feasible in pediatric Fontan patients. Haseba *et al*., 2017, examined the overall motor recovery of infants and toddlers with cyanotic and acyanoticCHD after early postoperative physical therapy in order to observe or not a difference during the recovery. The physical therapy intervention was applied an average of five days after surgery, where a significant reduction in the gross motor skills of each patient was observed compared to the preoperative phase. Both cyanotic and acyanoticCHD patients who received early postoperative physical therapy showed improved preoperative mobility scores until discharge. It was further observed that patients with cyanotic CHD had a significantly longer recovery period compared to those without acyanoticCHD. Therefore, according to the researchers, early postoperative physical therapy promotes recovery of gross mobility. In addition, infants with cyanotic CHD may be at greater risk of gross motor delays, and their recovery may differ from that of infants with cyanotic CHD after cardiac surgery.

Wittekind *et al*., 2018, through a prospective study, evaluated whether the participation of pediatric patients after Fontan surgery in cardiac rehabilitation programs will result in a more efficient oxygen extraction and better ventilation during submaximal exercise. The program lasted 12 weeks, consisting of two 60-minute sessions. Of the ten patients who completed the program, five had tricuspid atresia and the remaining five had hypoplastic left heart syndrome. Significant improvements in both submaximal and maximal exercise performance were observed in these patients, with no serious side effects, due in part to more efficient oxygen extraction and better ventilation. Staveski *et al*., 2018, performed a prospective, randomized controlled trial to evaluate the safety and feasibility of therapeutic massage in the immediate postoperative period after congenital heart surgery, examining the results of its application versus standard of care on postoperative pain and anxiety, and finally, evaluating the effect of opioids and benzodiazepines in patients receiving massage therapy. Sixty pediatric cardiac surgery patients aged 6 to 18 years participated in the study. The application of therapeutic massage in the immediate postoperative period in pediatric cardiac surgery patients was found to be safe and appropriate, with decreased anxiety scores at hospital discharge, while lower overall benzodiazepine exposure was observed. There were no adverse effects related to the massage application. Sutherland*et al*., 2018, examined whether a home exercise program could achieve similar improvements as an in-hospital program in patients after Fontan surgery. In their study, adolescents after Fontan surgery, aged 12-19 years, were divided into two groups, the group with the exercise program in the hospital and the group with the exercise program at home. The programs lasted 8 weeks, with two one-hour sessions each week. Similar performance was observed in both groups, with no patient experiencing exercise-related complications. Exercise after Fontan surgery is considered effective as it improves exercise capacity and patients' self-reported quality of life. According to this study home exercise programs are potentially as effective as hospital programs and should be incorporated into the follow-up care of patients undergoing Fontan surgery. Harrison *et al*., 2020, evaluated the effectiveness of massage compared to a period of rest on the postoperative pain and physiological responses of infants with complex CHD. The randomized clinical trial conducted involved two groups with a sample of 60 infants (aged 1 day to 12 months) after their first cardiothoracic surgery. Both groups received standard

postoperative care, but for 7 days, the first group received 30 minutes of daily massage, while the second group received 30 minutes of daily non-core care (quiet time). According to the measurements the massage group showed lower daily scores and a lower average daily heart rate and breathing rate, while there was little difference between the groups in oxygen saturation. Therefore, it was concluded that postoperative massage can reduce pain and improve physiological parameters in infants with CHD.

DISCUSSION – CONCLUSION

According to the existing literature cardiopulmonary rehabilitation physical therapy programs are equally effective when applied in the hospital or at home, while therapeutic exercise after surgery is considered effective as it improves exercise capacity and patients' self-reported quality of life (Sutherland *et al*., 2018). Therapeutic exercise in pediatric patients with CHD significantly contributes to the patients' cardiorespiratory performance, maximal oxygen consumption and uptake, oxygenation and functional capacity of the respiratory muscles, exercise endurance and, in general, an increase in daily activity levels is observed (Opocher*et al*.,2005, Brassard*et al*.,2006,Gomes-Neto*et al*.,2015,Sutherland*et al*., 2018). Also, early postoperative physical therapy promotes the restoration of gross mobility (Haseba*et al*., 2017). At the postoperative level, massage presented an analgesic effect and contributed to the improvement of physiological parameters in infants, while is generally a tolerable treatment and safe to apply after surgery, with no reported side effects (Staveski*et al*., 2018, Harrison*et al*., 2020). After the participation of patients in physical therapy programs, an improvement in physical, cognitive, scholastic and psychosocial functioning and a general improvement in quality of life was observed, especially in patients with a low initial quality of life (Jacobsen*et al*., 2016, Dulfer*et al*., 2014). In conclusion, the physical therapy intervention contributes positively to the postoperative rehabilitation of children and adolescents with CHD after surgery and improves the respiratory and psychosocial functioning of the patients, their mobility and, in general, the overall quality of life.

Suggestions

Based on the results of the above research studies of this paper, we propose:

1. Physiotherapy intervention in the pre-operative stage,
2. Early physical therapy intervention in the postoperative stage,
3. Training the patient in physical therapy techniques,
4. Implementation of the physical therapy program by the patient at home,
5. Implementation on a daily basis of the program to improve health and quality of life and finally,
6. Physiotherapy follow-up for one semester.

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