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The results of early physiotherapy on a child with partial anomalous pulmonary venous connection along with atrial and ventricular septal defect: A case report

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ABSTRACT

When the embryologic pulmonary venous system fails to connect with the left atrium, partial anomalous pulmonary venous connection (PAPVC), a rare congenital disorder, develops. Some pulmonary veins, but not all of them, empty in the right atrium. Atrial septal defects (ASDs), the second most prevalent congenital heart defect, are estimated to impact 2.6 out of every 1,000 live babies globally. The most frequent congenital heart defect is a ventricular septal defect (VSD), which usually coexists with other congenital abnormalities and can develop spontaneously or with mutations in the TBX5 and GATA4 genes. Following paediatric heart surgery, pain can worsen if it is not treated correctly due to patient manipulation, coughing, etc. Increased discomfort may be related to hypoxia, shallow breathing and hemodynamic responses (rapid rises in blood pressure and heart rate) (low SpO2). We describe a 2-year-old female patient who underwent PAPVC surgery, ventricular and atrial septal defect closure. This case report seeks to give readers a better understanding of cardio pulmonary rehabilitation for paediatric patients who have undergone ASD, VSD or PAPVC surgery. According to the WHO manifesto for children, every child is entitled to proper and uninterrupted physiological and intellectual development. Avoiding negative effects and reducing or eliminating disease-related disabilities, deformities and handicaps are the fundamental objectives of rehabilitation strategies. This case serves as an example of the importance and value of rapid physical rehabilitation following surgery. The patient's multidisciplinary rehabilitation plan will increase our understanding of the benefits of physical therapy for these patients.

Keywords: Atrial septal defect, Partial anomalous pulmonary venous connection, Cardio pulmonary rehabilitation, Ventricular septal defect, Physiotherapy, Congenital heart disease.

1. INTRODUCTION

Partial anomalous pulmonary venous connection (PAPVC), a rare congenital anomaly, results in some of the pulmonary veins draining into the right atrium because the embryologic pulmonary venous system fails to fuse with the left atrium (Li et al., 2019). The most prevalent kind of PAPVC is on the right side of the heart (Yenigün et al., 2020). Imaging frequently results in the unintentional identification of this unusual cardiac anomaly of the affected population, 10% of instances are left-sided (Khalil et al., 2018). Patients with abnormal pulmonary venous connections account for 10.6% of all cases reported in India. The left-to-right shunt that PAPVC produces is what causes the symptoms. Patients may express discomfort in their chest, palpitations, fatigue, dyspnea, or oedema. The aberrant vein must be evacuated into the left atrium as part of the standard PAPVC surgical procedure. Surgery produces positive results with minimal morbidity (Kamath et al., 2020).

The second most common congenital cardiac defect, atrial septal defects (ASDs), is thought to affect 2.6 out of every 1,000 live newborns worldwide. Undiagnosed ASDs continue to be important in paediatrics and 1 in 5,000 to 10,000 adults have one. Before the 1990s, only severe abnormalities with appreciably increased pulmonary blood flow had cardiac surgery because there was no other known treatment for ASD. Most people with ostium secundum ASDs receive their therapy primarily through percutaneous catheter closure (Amedro et al., 2018). ASD closure symptoms have been observed in patients with progressively less severe abnormalities, in elderly and younger youngsters and ASDs with mild pulmonary hypertension (Le-Gloan et al., 2018).

The most frequent congenital heart defect is a ventricular septal defect (VSD), which typically accounts for 32% of all heart conditions. It commonly coexists with other congenital abnormalities and can happen spontaneously or in connection with alterations to the TBX5 and GATA4 genes (Bravo-Valenzuela et al., 2018). Because it can identify foetal cardiac anomalies in adults without recognized risk factors, routine obstetric ultrasonography examination of the foetus is crucial (Adan et al., 2021). Using echocardiography to determine congenital cardiac conditions like VSD throughout gestation may be difficult. In addition to a group of specialists and subspecialists, sonographers are required. Additionally, many factors affect detection sensitivity, such as the operator's experience, the perinatal period and the placement of the foetus. Approximately 10 and 30 per cent of CHD patients die without treatment, which could result in the loss of patients with clinically severe CHDs (Penny and Vick, 2011).

Following paediatric heart surgery, pain can worsen if it is not adequately treated due to child handling, coughing, etc. Increased discomfort may be related to hypoxia, shallow breathing and hemodynamic responses (swift increase in blood pressure and pulse and reduced SpO2 levels). Concerning the respiratory, cardiac and psychosocial rehabilitation of children having heart surgery, the effectiveness is well established (Araujo et al., 2014).

Changes in breathing mechanics are frequently observed in children. Therefore, the primary goals of physiotherapy during the pre- and post-operative stages are to open the airways, promote lung re expansion and provide caregiver education (Sun et al., 2022). The pulmonary effects of teenage heart surgery included diaphragmatic paralysis, pneumothorax, atelectasis, chylothorax and pneumonia (Felcar et al., 2008).

Children with CHD commonly have complex cardiac anatomy that causes low blood oxygen levels, undergo several early-life surgeries, struggle with severely poor nutrition and regularly have healthcare prohibitions on their potential to participate in physical activity due to various pharmacological treatments, surgical healing or compromised hemodynamics. Parents' perceptions of the potential hazards of physical activity and their children's fragility may also restrict how much exercise the patient receives. Some cardiac groups may be more vulnerable to pre-transplant exercise intolerance due to these issues than others, who may experience more precipitous cardiac failure and superior fitness histories (Deliva et al., 2012). We discuss the case of a 2-year-old female infant with PAPVC, an atrial and ventricular septal defect and PAPVC repair in addition to ASD and VSD closure. This case report aims to provide insight into the cardiopulmonary rehabilitation of paediatric patients operated on for ASD, VSD and PAPVC.

2. CASE PRESENTATION

Patient Information

Upon admission, a 2-year-old girl's primary complaints included shortness of breath, fever and recurring cold and cough. The mother claims that the child has never been in good health and that starting at four months; she has to go to the doctor every month for a chest infection. The child has come to our hospital with shortness of breath, a fever, a cough and a cold. Breathing difficulties, feeding issues and cough without any cyanosis are all present, as an intermittent, high-grade fever that starts low grade and rises to 102–103 F. It is eased by taking antipyretics and is not related to chills. The mother also reported having the loose motion of grade III for the past three days that wasn't bloody or with mucus. It was accompanied by pronounced irritability, sunken eyes and decreased urine output. There were no H/O episodes, frequent vomiting, diarrhea and ear discharge or skin infections. She gives no

H/O contact with TB. On evaluation, the paediatrician heard a murmur and advised 2D ECHO. Upon investigations, the diagnosis of ASD-VSD and PAPVC was made. The patient was then advised surgical treatment. The patient was then referred for further management.

Past History

The young child has a history of two admissions for fever and cough, one in a private hospital and one in a government hospital. In the first admission, only symptomatic care was provided; the second admission lasted three days. They had numerous trips to the neighborhood doctor for recurrent chest infections. H/O blood transfusions are not done.

Birth History

Pre-natal

Antenatal visit done, ultrasound was done, multivitamins were taken. No other drugs were taken and no X-ray was done.

Natal

Term pregnancy, normal delivery

Post-natal

Cried immediately after birth no cyanosis, jaundice or fits. According to the mother, the baby had an average birth weight.

Feeding History

Weaning began six months following the commencement of breastfeeding, which started 3 hours after the baby was born—immunization: Vaccinated up to age.

General examination

Ill-looking, irritable female children with an average build lying on bed uncomfortably with mild intercostal recessions and having an IV cannula on her left hand. The patient's vitals were as follows, Respiratory rate: 55 beats/minute; Heart rate: 130 beats/minute; Temp.: 102 degrees F; BP: 95/60 mmHg. Anaemia and Dehydration were present. Pulse: 130 b/minute with average volume and character without any radio-femoral delay and was regularly regular. BP: 95/60 mmHg, Respiratory rate: 55 breaths/minute.

Inspection

Standard shape, no bulging, no scar, no visible pulsation; normal shape chest, no bulging, no deformity, no visible vein, no pulsation, no scar mark

Palpation

Apex beat was present in the 5th ICS medial to the midclavicular line. No left parasternal heave, thrill, trachea centrally placed and tenderness.

Auscultation

Harsh vesicular breathing with crackles audibles anteriorly on the left side of the chest. S1 and S2 are audible at all four areas of the heart with pan systolic murmur at the left sternal border of grade III (pre-operatively), No Radiation, having blowing character & high pitch.

Abdominal Examination

Inspection

Abdomen distended, umbilicus centrally placed inverted, no visible vein, pulsation or scar mark.

Palpation

Soft and non-tender

Investigations

Images below show pre-operative and postoperative chest x-rays.

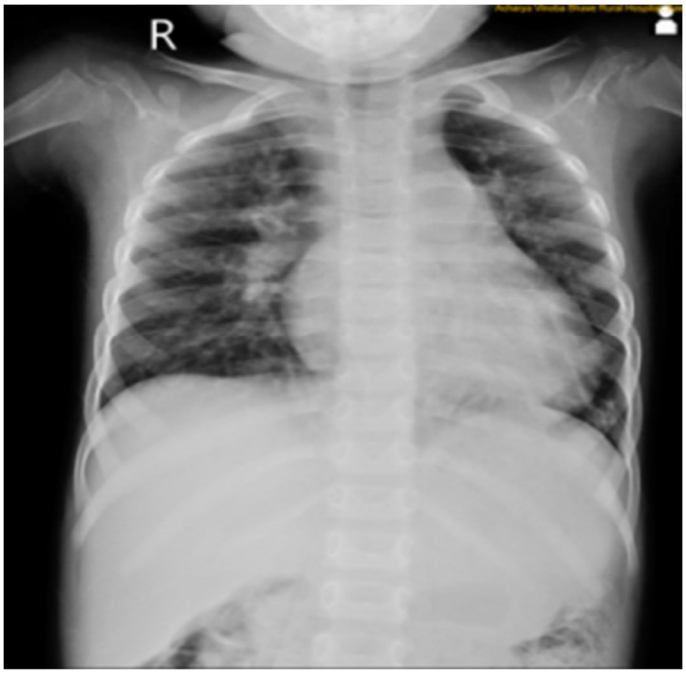

Figure 1 Shows the preoperative x-ray of the patient

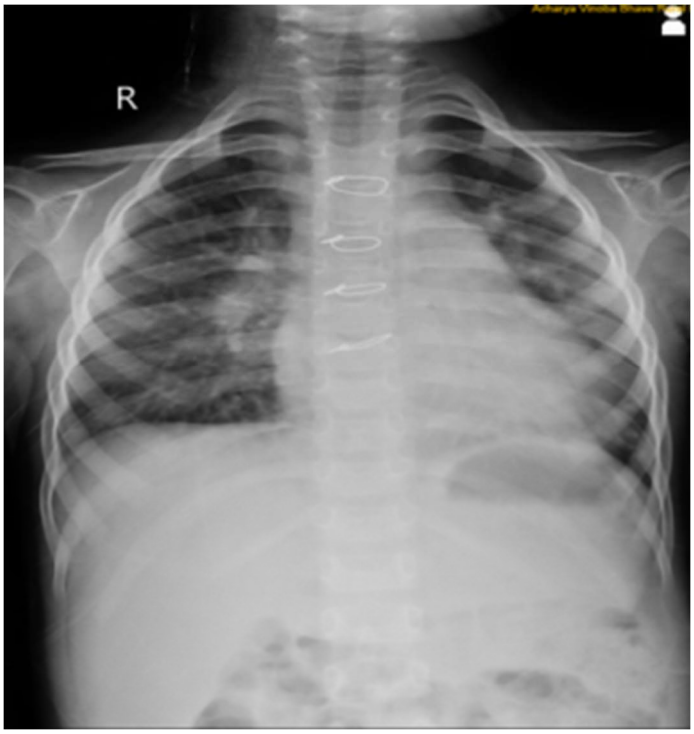

Figure 2 Shows the postoperative x-ray of the patient

Intervention

Goals for Rehabilitation

Each child is entitled to optimum and uninterrupted physiological, mental and emotional development following the WHO charter for children. The main goals of rehabilitation techniques are to avoid adverse effects and minimize or eliminate disease-related impairments, disabilities and handicaps. Other rehabilitation goals include sustainability, security and self-responsibility to help with self-help, encourage equitable social involvement and minimize or counter potential prejudice. In this regard, ensuring and restoring the affected human's reintegration into the family, society, workplace and educational system is vital. Patients' overall quality of life is improving and disease-related morbidity is decreasing (Bjarnason-Wehrens et al., 2007).

Table 1 Shows the goals and plan of rehabilitation

Goal	Plan
Clear of excess pulmonary secretion	Coughing Cupping
Provide ventilator support	Breathing exercise
Prevent complications from bed rest	Passive limb movement Active assisted limb movement Functional limb movement (active ROM)
Increased functional capacity (functional mobility)	Gradual mobilization Right side lying Left side lying Sitting with leaning on the bed Seated on the bed's edge Sit to stand Walking

Phase-wise rehabilitation

Pre-operative Rehabilitation

The physical therapist's priority during pre-operative heart surgery is to open a patent airway and promote adequate breathing. Education, which tries to inform parents of the advantage of physical therapy in minimizing pulmonary function decline in children and swiftly restoring it after it has occurred, is another crucial strategy. The patient then underwent upper extremity mobility exercises to improve mobility, maintain a decent range of motion and avoid contractures.

Postoperative Rehabilitation

Increased functional ability, improved quality of life, improved body composition (increasing the proportion of lean body mass to fat mass), increased general physical exercise beyond the training course and eventually decreasing the threat of potential cardiovascular illness are the goals of a paediatric cardiopulmonary rehabilitation programme. With the current awareness of the benefits of exercise, physical activity is rapidly being implemented into the everyday healthcare routines of many people with chronic conditions. Previously, physical fitness was not typically prescribed as a treatment (Somarriba et al., 2008).

Phase I

Table 2 Shows the phase I rehabilitation which initiated on postoperative day 1

Postoperative day	Physiotherapy treatment
1	Passive exercise all of the limb and transfer side lying to left and right Chest physiotherapy (cupping to clear excess pulmonary secretion) Sitting with head up at less than 30)
2	Passive exercise or active assisted exercise for all limbs and transfer ambulation Chest physiotherapy Sitting with head up more than 60
3	Active exercise Chest physiotherapy Sitting out of bed with support
4	Active exercise Sitting out of bed Sitting to stand
5	Active exercise Walk while holding on to something
6	Active exercise

	Walk alone
7	Active exercise 6 Minute Walk Test for measuring functional ability before discharge from hospital

Figure 3 Shows the patient standing with assistance on postoperative day 4

Phase II

Phase I is continued in this stage, which can be adopted for inpatient or outpatient care (Dimiati et al., 2020).

Phase III

Single-leg standing, standing on a soft cushion or tiptoeing are all examples of posture exercises.
Active mobility of the upper and lower limbs and chest expansions are all examples of flexibility exercises.
Exercises for breathing include blowing bubbles, resistance breathing, deep breathing and abdominal breathing.
Strengthening muscles by lifting the legs straight, crouching and rising from the floor, stimulating the gluteus muscles by hiding in a big box and tempting the kid with their favorite toys.
Stepping exercises, throwing and kicking a ball, climbing stairs and other developmental activities
Playing, riding and running to grab things with an obstruction in the way are all examples of aerobic endurance exercise.
Parents will do the treatment program at home over six months, for half-hour five days a week (Du et al., 2017).

Figure 4 Shows the patient playing and cycling

Follow-up and outcomes

Table 3 Shows the follow-up and outcome measures taken pre and post treatment

Outcome Measure	Pre-treatment	Post-treatment
Ross score	Class IV	Class I
The Wee FIM	Score 1 (Total Assistance)	Score 7 (Complete Independence)
The Zarit Caregiver Burden Scale	Moderate burden	Minimal burden

3. DISCUSSION

The efficacy of respiratory physiotherapy in the postoperative routine in the intensive care unit has been well-proven (Araujo et al., 2014). In premature newborns, chest physical therapy is safe; according to research by Mehta et al., (2016) suctioning alters cardio-respiratory parameters significantly, although within a physiologically reasonable range. Therefore, continuous monitoring during chest physical therapy should be used. The long-term consequences of chest physical therapy require further study.

In contrast to the intervention given immediately after surgery, the study by Felcar et al., (2018) showed that pre and postoperative therapy reduces the pulmonary difficulties in such children. This study monitored 135 children under six who underwent surgery and were split into two groups; one group underwent physical treatment before and after surgery, while the other only underwent physical therapy following surgery. Preoperative physical therapy patients had a significantly greater incidence of pneumonia, other lung problems and other issues like length of hospital stay.

Published reports back up this finding and the suggestion for physical therapy (PT) before and after surgery is based on lowering hospitalization and ICU stays (Hulzebos et al., 2006). Garcia and Piva, (2003) emphasized the need for comprehensive care for children with heart disease during all stages of cardiac surgery. Although the practice of including physiotherapy has grown in popularity, a thorough investigation is still required to establish the value of this activity.

Main et al., (2004) assessed the efficacy of aspiration with cardiopulmonary physical therapy approaches (postural drainage, percussion, positioning, compression, manual hyperinflation and manual vibration) in infants. In case no clinical intervention was required, the respiratory parameters (lung compliance, resistance and expiratory tidal volume) were measured 15 minutes before the therapy, after half hour and after one hour following the intervention. All have been found to improve with physiotherapy.

According to Kavanagh, (2008) atelectasis can be treated with deep breathing exercises, physiotherapy and incentive spirometry. After being extubated in the postoperative period, a child who underwent heart surgery experienced pulmonary problems. After respiratory physiotherapy and inhaling hypertonic saline solution, this situation was reversed. Atelectasis is typically challenging to reverse and requires a combination of procedures, as in the case study (Cavenaghi et al., 2009).

Early bed rest mobilization in the ICU can decrease functional mobility and lower the risk of pneumonia and an extended stay in

the ICU, according to Zang et al., (2019) it can also lessen the likelihood of developing these other illnesses. Zhang et al., (2019) evaluation of the effects of the practice suggests that early mobilization may shorten the period that patients are on ventilators.

Early mobilization contributes to decreasing oxidative stress and inflammation. Moderate exercise in the limb can increase protein against oxidative stress that can maintain muscle mass in critically ill conditions (Zang et al., 2020). Breathing exercises are a standard treatment given at the beginning of the early mobilization protocol. Anaesthesia, types of surgery, surgical trauma and existing health problems play a role in decreased lung volume, reduced cough activity and respiratory muscle fatigue. Lung function changes can cause complications and atelectasis, which are generally prevented with various techniques and chest physiotherapy (Koukourikos et al., 2020).

4. CONCLUSION

This case illustrates the significance and usefulness of early inpatient rehabilitation following surgery. The patient's inter disciplinary rehabilitation programme will contribute to the amount of knowledge on physical therapy for such patients. Early diagnosis, treatment and most importantly, rehabilitation played crucial roles in returning the patient to her functional state. A consistent fitness programme benefits the patient and lessens postoperative complications. Timely monitoring and therapy are anticipated to ameliorate patient outcomes in patients receiving multidisciplinary care.

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Author Contributions

AR, VV and VT: Contributed to the design and implementation of the research and to the writing of the manuscript.

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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