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CASE REPORT

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Aerobic Treadmill Training in a Children with Postinfectious Bronchiolitis Obliterans. Case Report

Entrenamiento aeróbico sobre cinta en un niño con bronquiolitis obliterante post infecciosa. Reporte de caso.

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ABSTRACT

Postinfectious bronchiolitis obliterans (PIBO) is a lung disease characterized by chronic airflow obstruction associated with inflammatory changes that lead to fibrosis and small airway obliteration. This results in chronic airflow obstruction and reduced tolerance to daily activities and exercise. The objective of this study was to describe the aerobic treadmill training plan in an 11-year-old patient with PIBO, which resulted in increased distance covered in the 6-Minute Walk Test and Maximal Exercise Capacity. This is the first case report of lung function rehabilitation in a pediatric patient with PIBO, to our knowledge.

Key words: bronchiolitis obliterans; Pediatrics; Aerobic exercise; Walk test

RESUMEN

La Bronquiolitis Obliterante Post Infecciosa (BOPI) es una enfermedad pulmonar caracterizada por obstrucción crónica al flujo de aire asociado a cambios inflamatorios, que conducen a fibrosis y obliteración de vía aérea pequeña. Esto genera una obstrucción crónica al flujo aéreo y reducción de la tolerancia a actividades de la vida diaria y al ejercicio. El objetivo de este trabajo es describir el plan de entrenamiento aeróbico sobre cinta en un paciente de 11 años de edad con BOPI, donde se obtuvo un aumento de la distancia recorrida en el Test de 6 Minutos y la Capacidad Máxima de Trabajo. Éste es el primer reporte de un caso de una rehabilitación de la función pulmonar en un paciente pediátrico con BOPI que tengamos conocimiento.

Palabras claves: Bronquiolitis obliterante; Pediatría; Ejercicio aeróbico; Test de marcha

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INTRODUCTION

Postinfectious bronchiolitis obliterans (PIBO) is a severe chronic obstructive pulmonary disease that develops after injury to the lower airways, followed by persistent inflammation, and leads to chronic airflow obstruction and fibrosis of the terminal bronchioles.[1,2] As a consequence, there is a progressive loss of ventilatory muscle strength, a reduction in the ability to perform physical activity, and decreased exercise tolerance.[3]

In our country, PIBO most commonly occurs secondary to severe viral infections, especially those caused by adenovirus.[4,5] In other countries, it is more commonly a consequence of bone marrow or lung transplantation.[6]

Postinfectious bronchiolitis obliterans usually occurs in children under 12 months of age. Initially, during hospital admission, patients present with symptoms that do not differ from those of severe bronchiolitis; most have severe airway obstruction with hypoxemia, and in many cases require mechanical ventilation. Once established, PIBO is clinically characterized by tachypnea, increased anteroposterior chest diameter, crackles, wheezing, and hypoxemia lasting for at least 30 days after the initial injury. High-resolution chest computed tomography (CT) shows characteristic mosaic patterns and bronchiectasis.[23]

Reduced exercise tolerance in patients with chronic respiratory diseases impairs quality of life, increasing hospitalization rates and medication use. Functional tests, such as the six-minute walk test (6MWT) and cardiopulmonary exercise testing (CPET), are tools used to measure overall physical capacity. The 6MWT is particularly valuable because of its simplicity and reliability, with good correlations in children with chronic respiratory diseases.[7,8] Additionally, the 6MWT has gained increased use in recent years as a prognostic indicator of disease severity in cystic fibrosis.

Research on bronchiolitis obliterans (BO) predominantly addresses post-transplant cases, with limited data available on postinfectious BO.[9] Studies on aerobic training have mainly focused on adults with chronic obstructive pulmonary disease (COPD). Cases have also been reported in children with asthma and cystic fibrosis,[10,11] but not in children with PIBO. Therefore, the aim of this study was to describe an aerobic training program carried out in a patient with PIBO and its impact on clinical variables.

CASE DESCRIPTION

The 11-year-old boy, diagnosed with PIBO and chronic airflow obstruction, was referred by his pediatrician to begin pulmonary rehabilitation. He was born in 2013 via C-section at 38 weeks' gestation. At one year of age, he was hospitalized for massive atelectasis caused by pneumococcus, when left pulmonary necrosis with involvement of the right lung base was identified. After prolonged use of mechanical ventilatory assistance and two failed extubation attempts, a tracheostomy was performed, and he remained in the Pediatric Intensive Care Unit for two months. He was discharged requiring continuous oxygen, and underwent decannulation at age four; however, he has required ongoing home oxygen due to chronic hypoxemic respiratory failure ever since. The care team consisted of the primary pediatrician, a pulmonologist, motor and respiratory physical therapists, a nutritionist, a nurse, and therapeutic support at school.

Therapeutic intervention

At 11 years of age, the patient underwent aerobic training between April and May 2024 in a private practice in the city of San Nicolás, Province of Buenos Aires. He was evaluated at the beginning and at the end of the treatment using the 6MWT and CPET. The 6MWT was performed in accordance with the recommendations of the ATS (American Thoracic Society),[11,12] which recorded the total distance walked, respiratory rate (RR), heart rate (HR), and oxygen saturation (SpO_2) using a portable Nonin pulse oximeter (Nonin Advantage 9590), at baseline and immediately after the test (Table 1).

The treadmill-based CPET (Life Fitness T9i Treadmill, Illinois) was used to establish maximal exercise capacity. The test began with a 3-minute warm-up, and the speed increased by 0.5 km/h every minute until the appearance of any of the stopping criteria described by Torres-Castro et al (2016).[13] During the test, maximum speed achieved, HR, SpO_2, and Borg dyspnea scores were recorded (Table 2).

Treadmill training plan

The plan consisted of 24 sessions (three per week) with intervals of moderate and high intensity and continuous monitoring of vital signs. During the first three sessions, workloads of 50% and 80% of

TABLE 1. Values obtained in the physiological variables of the 6MWT before and after treatment

Physiological variables	Before	After	% of change
HR at rest (bpm)	103	89	-13.59
Final HR (bpm)	151	154	1.98
RR at rest (bpm)	30	27	11.11
Final RR (bpm)	38	34	–1052
Baseline O_2 sat	95	96	1
Final O_2 sal	90	93	–3.33
Baseline SAP/ DAP (mmhg)	138/80	135/80	–2.17/0
Final SAP/ DAP (mmhg)	150/88	140/88	–15.66/0
6MWT (meters)	180	255	–41.66

HR: heart rate; **RR:** respiratory rate; **O_2 sat:** oxygen saturation; **SAP:** systolic arterial pressure; **DAP:** diastolic arterial pressure; **6MWT:** 6-minute walk test.

TABLE 2. Incremental load test before and after aerobic treadmill training

Before training					After training					% of change
Time	Speed km/h	O_2 sat	HR	Dyspnea	Time	Speed km/h	O_2 sat	HR	Dyspnea	
1’	3	96	117	1	1´	3	96	110	0,5	
1’	3.5	94	130	2	1´	3.5	95	119	1	
1’	4	91	150	7	1´	4	94	130	2	
						4.5	92	146	4	
						5	91	151	5	
						5.5	90	160	7	
MAS 4 km/h					MAS 5.5 Km/h					–37.5

O_2 sat: oxygen saturation; **HR:** heart rate; **MAS:** maximal aerobic speed.

the speed obtained in the CPET were used; in the following six sessions, intensities of 50% and 85% were applied; and in the remaining 15 sessions, interval intensities ranged between 50% and 90%. The type of training was high-intensity interval training (HIIT).

Each session included 3 minutes of warm-up with mobilization of the shoulder, hip, and ankle joints, trunk rotations, and stretching of the posterior muscle chain; followed by 30 minutes of training with intervals of 1 minute of exercise and 2 minutes of passive recovery; and finally, a 2-minute cool-down with monitoring of heart rate, oxygen saturation, and dyspnea. At each session, the date, duration, training intensities, and vital signs (at baseline and post-session) were recorded.

RESULTS

The results of the 6MWT showed that post-training baseline heart rate was lower at the end of treatment (Table 1), indicating reduced cardiovascular effort to perform the test. Although the final heart rate was 154 bpm with a change of 1.98%, the distance covered increased by 41.66%. In the CPET, the maximum aerobic speed was 5.5 km/h, with an improvement of 1.5 km/h (Table 2). Dyspnea also showed improvement, reflecting vascular adaptation.

DISCUSSION

This case report describes the aerobic training plan in a child with PIBO and shows changes in physiological variables related to physical capacity, as reflected in the 6MWT and CPET both before and after treatment.

The main causes of exercise intolerance in patients with pulmonary disease include factors such as lower limb fatigue, dyspnea, dynamic hyperinflation, peripheral muscle dysfunction, abnormalities in oxygen transport, and physical deconditioning due to inactivity. The lack of ventilatory reserve –evidenced by high ventilation during cardiopulmonary exercise testing– is associated with poor physical performance and can be attributed to an obstructive pattern that limits airflow.[14]

The distance walked in the 6MWT improved by 41.66% after aerobic treadmill training; and post-treatment resting heart rate was lower than baseline values, indicating reduced cardiovascular effort to perform the test (Table 1). Although training does not produce morphological changes, cardiovascular and functional improvements can be observed. This increase was reported by Grumber et al and Latorre-Román et al, who observed significant improvements of 4% and 23%, respectively, in the 6MWT after an aerobic training protocol in children with cystic fibrosis and asthma.[15,16] Regarding the physiological variables evaluated in the 6MWT, Moalla et al observed a similar HR response in children with congestive heart disease, attributing this response to changes in autonomic tone as a result of endurance training.[17]

With respect to CPET, although maximal aerobic speed (MAS) increased by only 1.5 km/h, the patient tolerated a longer workload duration, demonstrating adequate resistance to the stimulus. (Table 2). Concerning dyspnea during the pre-treatment CPET, the test ended with a dyspnea score of 7 at 3 minutes, whereas post-treatment the patient reached a dyspnea score of 7 after 6 minutes, indicating a significant vascular adaptation. Longitudinal studies have shown that forced expiratory volumes undergo significant increases between 5 and 20 years of age; however, forced vital capacity (FVC) increases disproportionately (+11% per year) compared with FEV_1 (+9%), leading to a progressive reduction in the FEV_1/FVC ratio (−1.9%).[7,18] This phenomenon is likely related to neoalveolarization during childhood and adolescence (Narayanan et al, 2013).[22,23]

In pediatric patients with chronic respiratory disease (CRD), the assessment of physical fitness is considered part of a multidimensional evaluation, as it assesses interaction among the cardiac, ventilatory, muscular, and metabolic systems.[3] These findings highlight the importance of the team that thoroughly evaluates these patients, taking into account that other factors –such as habitual physical activity level, physical conditioning, and muscular capacity (both peripheral and respiratory)– may also play an important role in their aerobic fitness.[3] The guidelines published by Torres-Castro et al (2016), currently in force in our country, recommend regular general physical training at threshold intensity in order to trigger physiological response and adaptation mechanisms.[7,13]

At present, there are no studies specifically designed to evaluate the effects of physical training in patients with PIBO. Existing studies have been conducted in patients with post-transplant bronchiolitis obliterans and in individuals with other chronic respiratory diseases, such as cystic fibrosis.[18] The available evidence indicates that physical training protocols are effective in improving physical capacity, exercise tolerance, and cardiovascular fitness in patients with chronic respiratory diseases.[7,19,20,21]

One limitation of this study is that, as it is a single case report, the results are not generalizable to other patients. Nevertheless, it may serve as a starting point for future studies with larger sample sizes and multicenter designs, given that this is a rare condition.

CONCLUSION

An improvement in exercise capacity was observed in a child with PIBO following an aerobic treadmill training program, with increases in the distance covered in the 6MWT and greater tolerance to workload duration in the CPET. Despite challenges related to pulmonary health, the patient experienced improvements in overall physical capacity.

Conflict of interest

The authors have no conflicts of interest to declare.

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