Case Report

Access this article online
Quick Response Code:

Website:
https://eurasianjpulmonol.org
DOI:
10.14744/ejp.2024.2001

The role of pulmonary rehabilitation in multidisciplinary approaches: A case of disseminated tuberculosis

Manivel Arumugam[1], Malathy Dhanabal Varunn[2], Senthil Dhanasekaran[2], Pitchaimani Govindharaj[3]

ORCID:
Manivel Arumugam: 0000-0002-6285-2378
Malathy Dhanabal Varunn: 0000-0003-0707-8479
Senthil Dhanasekaran: 0009-0008-1539-9532
Pitchaimani Govindharaj: 0000-0002-3637-3760

Abstract:

Disseminated tuberculosis (TB) is a mycobacterial infection where mycobacteria spread from the lungs to other body parts through the blood or lymph system. It occurs in a small number of infected individuals, when the immune system doesn't contain the primary infection. Extrapulmonary symptoms of TB, such as muscle weakness, cachexia, and depression, may persist for an extended period. A pulmonary rehabilitation (PR) program could be a useful intervention in both the active phase and the sequelae phase of treatment. In this case study, we present a report of a young male diagnosed with disseminated TB. He was admitted to the Medical College and Hospital due to worsening hypoxia associated with pneumothorax, and underwent placement of repeated intercostal drains with oxygen support. After medical stabilization, he was referred to the pulmonary rehabilitation unit, where he achieved remarkable results and recovered well.

Keywords:

Disseminated tuberculosis, exercise program, pulmonary rehabilitation, tuberculosis, 6-minute walk test

[1]Pulmonary Rehabilitation Unit, Department of Pulmonary Medicine, PSG Hospitals, PSG Institute of Medical Sciences and Research, Tamil Nadu, India, [2]Department of Pulmonary Medicine, PSG Hospitals, PSG Institute of Medical Sciences and Research, Tamil Nadu, India, [3]Department of Allied Health Sciences, Sri Ramachandra Faculty of Allied Health Sciences, Sri Ramachandra Institute of Higher Education and Research (DU), Tamil Nadu, India

Address for correspondence:
Dr. Manivel Arumugam, Pulmonary Rehabilitation Unit, Department of Pulmonary Medicine, PSG Hospitals, PSG Institute of Medical Sciences and Research, Tamil Nadu, India.
E-mail: arumani_005@yahoo.co.in

Received: 16-02-2024
Revised: 29-06-2024
Accepted: 06-07-2024
Published: 23-01-2025

Introduction

Disseminated tuberculosis (TB) is defined as the presence of two or more non-contiguous sites resulting from lymphohematogenous dissemination of Mycobacterium tuberculosis.[1] It may occur as a result of progressive primary infection or the reactivation of a latent focus, with subsequent lymphohematogenous spread. Delayed diagnosis and treatment can lead to a life-threatening condition for the affected individual.[1] Disseminated tuberculosis occurs when an individual has a weakened immune system due to disease or the use of certain medications such as immunosuppressive medications for various medical disorders. The clinical presentation varies and commonly includes both subacute and

How to cite this article: Arumugam M, Varunn MD, Dhanasekaran S, Govindharaj P. The role of pulmonary rehabilitation in multidisciplinary approaches: A case of disseminated tuberculosis. Eurasian J Pulmonol 0000;00:1-7.

chronic constitutional symptoms such as fever, weight loss, night sweats, anorexia, pyrexia of unknown origin, and multiorgan failure, reflecting the affected underlying organs. Tuberculosis can significantly impact various aspects of a patient's life, including muscle strength, exercise tolerance, nutritional status, psychological state, and health-related quality of life (HQoL).[2] Due to a high degree of physical and mental deconditioning, pulmonary rehabilitation (PR) is essential for individuals with TB to enhance their HQoL.

Pulmonary rehabilitation is a specialized program supervised by a medical team that helps individuals with lung disease live and breathe better. Studies have shown that PR programs are effective in treating the sequlae of TB, improving exercise tolerance, symptoms, and HQoL.[3–5] An early start to a comprehensive PR program may enable patients with TB to reintegrate into society and return to work after hospital discharge.[6] This study aims to present a case of an eighteen-year-old male patient with disseminated tuberculosis and the outcomes of his pulmonary rehabilitation.

Case Report

An eighteen-year-old male college student with no known comorbidities presented to a local hospital with a fifteen-day history of fever, vomiting, tiredness, and weakness in the upper and lower limbs. Initial laboratory analysis revealed anemia, thrombocytopenia, and elevated C-reactive protein levels. In view of the patient's symptoms, including cough, breathlessness, weight loss, and generalized deconditioning, further investigations were conducted, including chest X-ray, computed tomography (CT), and magnetic resonance imaging (MRI). The reports revealed bilateral pneumothorax with right hydropneumothorax, right lung cavitary consolidation, TB spondylitis, and nodules in both the right (lower lobe) and left lung (upper lobe) [Figs. 1a and 2a]. The cerebrospinal fluid (CSF) culture tested positive for gram-positive bacilli. He was diagnosed with right lung pneumonia and bilateral pneumothorax; therefore, bilateral intercostal drainage (ICD) tubes were inserted consecutively within a week [Fig. 1b].He was started on empirical anti-tuberculosis treatment (ATT) and referred to our hospital, the Medical College and Hospital, with bilateral ICD for further management.

He was evaluated for cavities with pneumothorax, osteolytic vertebral lesions, a large ileal ulcer, differential diagnoses including polyneuropathy with quadriparesis, andLangerhans cell histiocytosis. Bone marrow studies were conducted along with culture and sensitivity tests; bone marrow biopsy revealed granulomatous inflammation. GeneXpert panels were positive for TB, suggesting disseminated tuberculosis, and rifampicin resistance was not detected. Persistent air leaks in the ICDs were managed with blood patch pleurodesis to reduce the leaks. Hence, ATT was continued [initial two months during inpatient care: T. Rifampicin (450mg) + Isoniazid (300mg) once daily (OD), T. Ethambutol hydrochloride (800mg) OD, T. Pyrazinamide (1250mg) OD; after discharge from the hospital: T. Rifampicin (450mg) + Isoniazid (300mg) OD, and T. Ethambutol hydrochloride (800mg) OD for 7 months], along with other medications like iron supplements, antibiotics, multivitamins, as well as additional supportive medical treatments and psychiatric interventions. The patient was admitted into the pulmonary department for a pulmonary rehabilitation program due to prolonged hospitalization with an ICD tube (more than 2 months) in a bedridden state and muscle deconditioning.

Pulmonary rehabilitation program

In the active TB phase, the exercise recommendations may start light, beginning with passive exercises and progressing to active-assisted and then active exercises. Slow-paced exercises are initially advised, focusing on enhancing postural control and precision. Over time, resistance training, which involves developing muscle strength by increasing repetitions or using heavier weights, will be applied, taking into account the patient's progress. Both the upper and lower limbs should be targeted to improve strength for better mobility. When the patient's condition stabilizes, a walk test may be conducted in a hospital ward room or corridor, followed by static cycling and resistance training. The intensity of these activities should be gradually increased based on the patient's individual tolerance.[7]

In accordance with the American Thoracic Society guidelines, we initiated Phase 1 pulmonary rehabilitation with appropriate consent from both the patient and family members. Nutritional status was enhanced through dietary corrections, and psychological counselling was provided, helping the patient overcome anxiety and depression. Following clearance from the consulting physician, the exercise-based intervention was initiated.

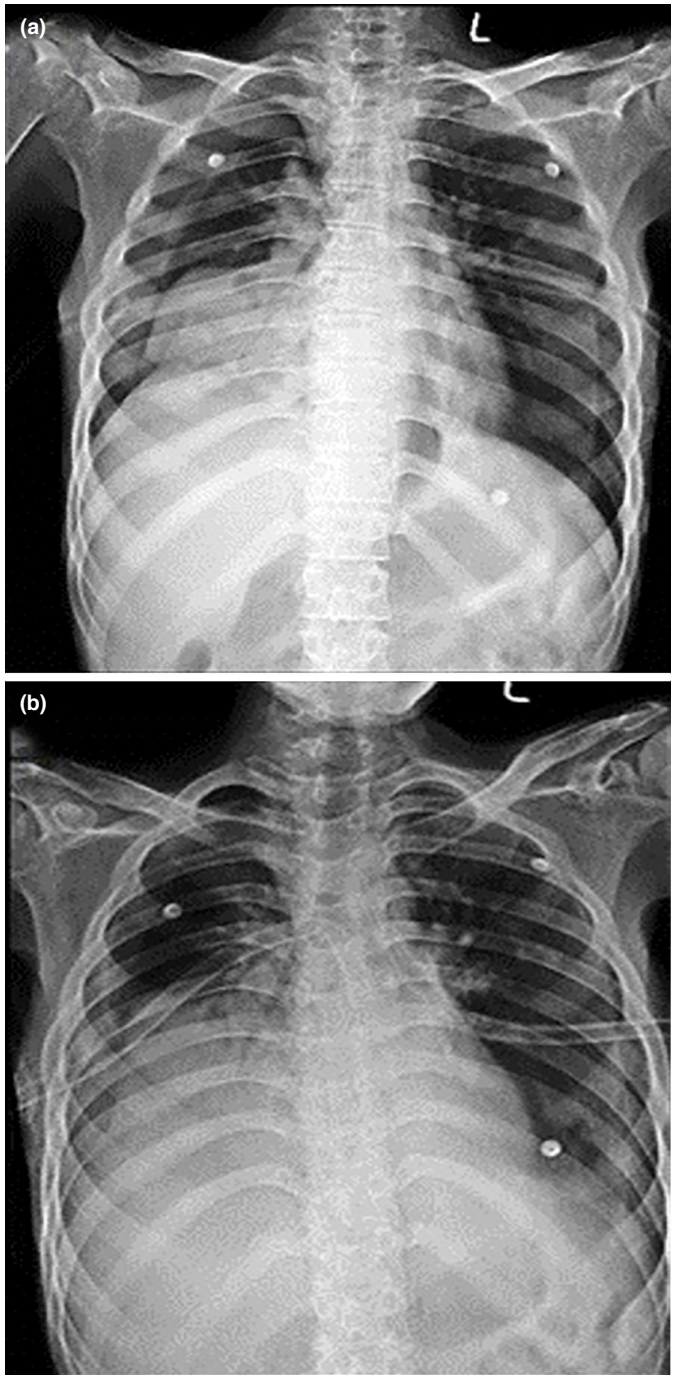

Figure 1: Initial chest X-ray. (a) Initial chest X-ray at reporting time; (b) Initial chest X-ray after admission

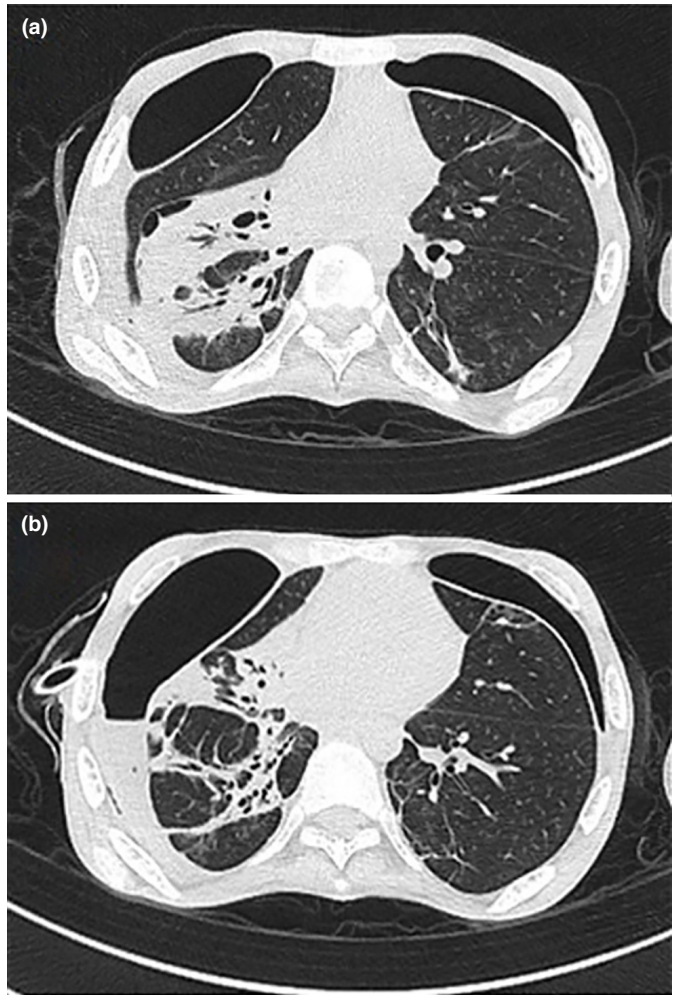

Figure 2: Chest computed tomography (CT) initially and three months after the pulmonary rehabilitation (PR) program: (a) Initial chest CT; (b) Chest CT at three months after the PR program

Outcome measures were collected before the PR program (initial), during the PR program (one month), and after discharge from the hospital (follow-up at the third and sixth month post-rehabilitation). These measures included a 6-minute walk test,[8] a one-minute sit-to-stand test, and physical activity questionnaires, which include the Functional Independence Measure of self-care domains such as eating, grooming, bathing, dressing upper and lower body, and toileting (ranging from total assistance, score 1, to complete independence, score 2), and the Physical Activity Index (ranging from poor to highly active). Dyspnea was evaluated using the Modified Borg's Scale (ranging from 0, nothing at all, to 10, very, very hard) and handgrip strength was measured with a modified sphygmomanometer.[9] Additionally, the girth of the upper and lower limb muscles was measured to assess changes in muscle wasting.

The PR program includes flexibility training, strength training, endurance training, airway clearance techniques, breathing retraining, educational support, psychological counseling, and nutritional interventions as required (Table 1). The intensity was adjusted according to his tolerance.

Table 1: Protocol of the pulmonary rehabilitation program

Phase I: Acute Phase (Duration: 4 weeks from the initial period)	
Goals:	• Optimize lung expansion and secretion clearance. • Retrain breathing patterns. • Maintain upper and lower extremity range of motion (ROM), strength, and basic bed mobility and transfers.
Exercise program in acute phase	
Airway clearance:	• Postural drainage positions advised for 5–10 minutes before meals, morning and evening (first two weeks), with the active cycle of breathing techniques.
Breathing retraining:	• Breathing synchronized with abdomino-thoracic movement, 15–20 repetitions, 3–4 times/day. • Gradually progress to 10–15 repetitions of diaphragmatic and thoracic expansion exercises with manual resistance.
Deep Vein Thrombosis (DVT Prophylaxis and ROM:	• Pneumatic compression device applied during nighttime and sleep. • Active ankle pumps, calf stretching, squeezing, and other ROM exercises performed upon waking, 15–20 repetition, 3–4 times/day.
Exercise program in acute maintenance phase	
Early mobilization:	• Begin with long sitting or bedside sitting, being cautious about all tubes and drains, 10–30 minutes daily • Progress to chair sitting after drain removal.
Cardiopulmonary Endurance training:	• Leg cycling with a mini pedal exerciser for 10–20 minutes once daily. • Standing marches, 10–15 repetitions twice daily, depending on tolerance.
Walking training:	• Initially walk for 5–10 minutes with 2–4 L/min oxygen to maintain SpO_2 above 90%. • Progress to 20 minutes, twice daily, with 2–3 L/min oxygen support, with adequate rest between sessions.
Phase II: Inpatient rehabilitation program at ward frequency: 5–6 days/week (Duration: 4 weeks)	
Endurance training:	• Level walking as tolerated for 10–20 minutes, based on patient's walking speed or using the six-minute walk test (6MWT), or targeting a modified Borg scale intensity of 4–6/10. • Arm and leg cycling ergometer for 10–20 minutes, 5–6 days per week, aiming for a Borg scale intensity of 4–6/10.
Strength training:	• Target muscle groups trained with dumbbells and weight cuffs for up to 2 weeks (upper limb weight lifting is avoided due to repeated intercostal drainage (ICD) insertions and poor wound healing). • Upper limb: biceps, triceps, deltoid, pectorals. • Lower limb: quadriceps, hamstrings, gluteus muscles, calf, and dorsiflexors, using 0.5–2 kg weights, 10 repetitions, 2 sets, performed on alternate days.
Breathing retraining exercises:	• Focus on breathing control through diaphragmatic breathing and localized thoracic expansion exercises, 15–20 repetitions, performed every 2–3 hours once daily. • Breathing exercises performed in sitting, semi-Fowler's, side-lying, and supine positions, with gradual progression. • Paced breathing is practiced during activities.

After receiving approval from the pulmonologist, the PR program was immediately initiated and continued 4 to 6 days per week until the time of discharge (eight weeks). The patient was advised on homecare activities to improve his health condition, which included walking, breathing exercises, and resistance exercises using simple objects such as sandbags and water bottles. The study outcome measures are shown in Tables 2 and 3.

Discussion

In multidisciplinary approaches, various treatment modalities are employed, including thoracic surgery, tuberculosis drugs, nutritional support, and psychiatric support, to treat disseminated tuberculosis. Pulmonary rehabilitation is also one of the approaches to treat physical deconditioning in patients with disseminated tuberculosis.

The PR program demonstrated significant improvements in exercise performance and health-related quality of life for the young male patient from the day of admission until discharge. Initially, the patient was apprehensive about the PR due to long-standing hospitalization, repetitive insertion of ICD tubes, pain during procedures, transfers to the CT and X-ray rooms, weight loss, poor nutritional intake, and isolation. Through continuous psychological counseling, appropriate ATT treatment with supportive medications, and oxygen support, the symptoms of

Table 2: Outcome measures 1 - hemogram and other biochemistry values

Outcome measures	Assessment			
		Follow-up		
	Initial	First month	Third month	Sixth month
Hematology				
Hemoglobin (g/dL)	8.1	8.5	12.4	12.1
Red blood cells (uL)	2.90×10^{6}	3.2×10^{6}	4.54×10^{6}	4.61×10^{6}
Hematocrit (%)	24.6	26	38.8	37.3
Total white blood cells (u/L)	12.0×10^{3}	29.09×10^{3}	15.47×10^{3}	19.1×10^{3}
Neutrophil (%)	87.5	87.7	76.5	79.4
Lymphocyte (%)	5.2	2.9	15.6	10.9
Monocyte (%)	6.3	5.0	5.6	8.2
Eosinophil (%)	0.2	0.5	1.7	1.0
Basophil (%)	0.8	3.9	0.6	0.5
Platelet (u/L)	140×10^{3}	674×10^{3}	559×10^{3}	550×10^{3}
Liver function test				
Bilirubin (Serum: Total/direct/indirect)	1.0/0.4/0.6	0.6/0.3/0.3	1.2/0.8/0.4	0.2/0.1/0.1
Alanine transaminase (U/L)	11	22	21	10
Aspartate aminotransferase (U/L)	29	47	59	21
Alkaline phosphatase (U/L)	69	126	111	96
Proteins (Serum)				
Albumin (g/dL)	3.1	2.5	2.4	4.0
Globulin (g/dL)	3.5	6.0	4.2	3.0
Gamma-glutamyl transferase (U/L)	49	73	35	17
Renal function test				
Urea (mg/dL)	13	16	20	18
Creatinine (mg/dL)	0.30	0.29	0.46	0.36
Sodium (mEq/L)	124	134	140	136
Potassium (mEq/L)	2.8	5.35	4.25	4.11
Chloride (mEq/L)	100	98	100	101
Bicarbonate (mEq/L)	22.1	28.4	28.7	29.4
Ionized calcium (mmol/L)	0.81	0.91	1.217	1.15
Magnesium (mEq/L)	1.44	1.22	1.37	1.61

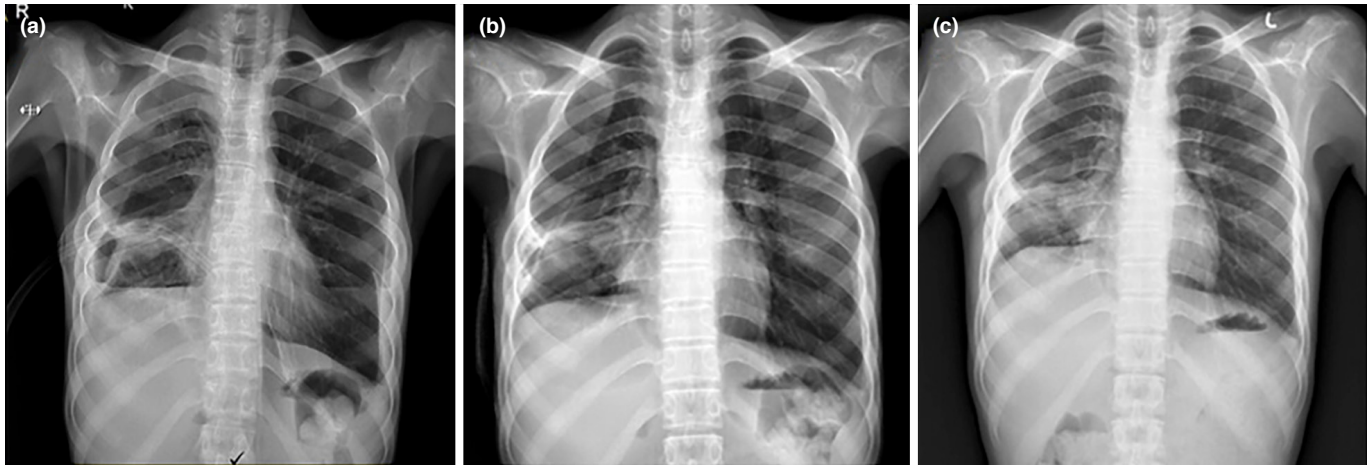

Figure 3: Chest X-ray after the PR program at 2 months, 3 months, and 6 months. (a) Chest X-ray at 2 months after the PR program; (b) Chest X-ray at 3 months after the PR program; (c) Follow-up chest X-ray at 6 months after the PR program

PR: Pulmonary rehabilitation

Table 3: Outcome measures 2

Outcome measures	Assessment			
		Follow-up		
	Initial	First month	Third month	Sixth month
Anthropometric parameters				
Height (cm)	174	174	174	174
Weight (kg)	31.4	35.2	42.1	54.1
BMI (kg/m^2)	10.39	11.65	13.94	17.91
Hand grip (mmHg)				
Right hand	15	30	40	70
Left hand	12	25	35	50
6 minute walk distance	95 meters (17.16%)	120 meters (19.66%)	180 meters (31.59%)	300 meters (51.04%)
One minute sit-to-stand	3 times/min	7 times/min	10 times/min	18 times/min
SpO_2% desaturation during activities	-23% (97–74%) 6 L/min	-17% (96–79%) 3 L/min	-17% (98–81%) Room air	-11% (98–87%) Room air
Δ Heart rate difference (beats/min) during exercise	34 beats (120–154 beats/min)	22 beats (126–148 beats/min)	34 beats (118–152 beats/min)	24 beats (130–154 beats/min)
Modified borg scale (Dyspnea)	8/10	6/10	5/10	3/10
FIM scale (Self-care domain)	6/42 (14%) Maximal assistance	13/42 (26%) Maximal assistant	24/42 (57%) Moderate assistance	35/42 (83%) Supervision
PAI 6	36 (Sedentary)	48 (Poor, not good enough)	60 (Fair, acceptable)	(Very good, active, and healthy)
Limb circumference	**Right**	**Left**	**Right**	**Left**
Mid thigh (cm)	33.5	32.0	40.5	43.0
Mid calf (cm)	27.5	27.0	32.0	31.5
Mid arm (cm)	22.2	21.3	24.0	23.3
Mid forearm (cm)	17.6	17.2	19.5	18.5

FIM: Functional independence measure, PAI: Physical activity index

pneumothorax and air leaks in the ICDs were managed. With adjustments to analgesics and the initiation of graded mobilization, the patient became more satisfied with his health improvements and participated more actively and fully in the PR program sessions.

Initially, the patient required maximal assistance for mobilization, which was gradually reduced to supervised mobilization. At first, he could participate in exercise sessions for fifteen to thirty minutes, but by the time of discharge from the hospital, he was able to tolerate up to two hours. He demonstrated significant improvement in exercise capability, which was evident during endurance exercises and walking, and also showed reduced dyspnea levels, increased regular physical activity, and improved muscle strength. Improvements in lung condition are shown in Figures 2b and 3 (3a at 2 months, 3b at 3 months, 3c at 6 months). There was also evidence of a positive trend in reducing depressive symptoms. The PR program was safe, well-received,well-tolerated, and had a high rate of adherence. Additionally, the patient's family members showed increased interest and actively supported the PR sessions. They were induced and demonstrated how to continue exercises at home.

Our case report clearly demonstrates the significance and benefits of a PR program. The study shows a noticeable improvement in the physical condition of the patient. The PR program may be an effective adjunct therapy to pharmacological treatment, improving the physical quality of life for individuals with chronic conditions like disseminated TB.

Informed Consent

Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

Authorship Contributions

Concept – M.A.; Design – M.A.; Supervision – M.D.V., S.D.; Materials – M.D.V., S.D.; Data collection &/or processing – M.A.; Analysis and/or interpretation – M.A., P.G.; Literature search – M.A., P.G.; Writing – M.A., P.G.; Critical review – M.A., M.D.V., S.D., P.G.

Conflicts of Interest

There are no conflicts of interest.

Use of AI for Writing Assistance

No AI technologies utilized.

Financial Support and Sponsorship

Nil.

Peer-review

Externally peer-reviewed.

References

1. Khan FY, Dosa K, Fuad A, Ibrahim W, Alaini A, Osman L, et al. Disseminated tuberculosis among adult patients admitted to Hamad general hospital, Qatar: A five year hospital based study. Mycobact Dis 2016;6:212. [CrossRef]
2. Maguire GP, Anstey NM, Ardian M, Waramori G, Tjitra E, Kenangalem E, et al. Pulmonary tuberculosis, impaired lung function, disability and quality of life in a high-burden setting. Int J Tuberc Lung Dis 2009;13(12):1500–6.
3. Jones R, Kirenga BJ, Katagira W, Singh SJ, Pooler J, Okwera A, et al. A pre-post intervention study of pulmonary rehabilitation for adults with post-tuberculosis lung disease in Uganda. Int J Chron Obstruct Pulmon Dis 2017;12:3533–9. [CrossRef]
4. Tada A, Matsumoto H, Soda R, Endo S, Kawai H, Kimura G, Yamashita M, Okada C, Takahashi K. Effects of pulmonary rehabilitation in patients with pulmonary tuberculosis sequelae. Nihon Kokyuki Gakkai Zasshi 2002;40(4):275–81. Japanese.
5. Ando M, Mori A, Esaki H, Shiraki T, Uemura H, Okazawa M, et al. The effect of pulmonary rehabilitation in patients with post-tuberculosis lung disorder. Chest 2003;123(6):1988–95. [CrossRef]
6. Chapman CE, Hollander AG. Tuberculosis and rehabilitation: Dynamic physical restoration of patients with active disease. Calif Med 1964;100(2):88–91.
7. Mahler B., Croitoru A. Pulmonary rehabilitation and tuberculosis: a new approach for an old disease. Pneumologia 2019;68(3):107–113. [CrossRef]
8. Palaniappan Ramanathan R, Chandrasekaran B. Reference equations for 6-min walk test in healthy Indian subjects (25-80 years). Lung India 2014;31(1):35–8. [CrossRef]
9. Chandrasekaran B, Ghosh A, Prasad C, Krishnan K, Chandrasharma B. Age and anthropometric traits predict handgrip strength in healthy normals. J Hand Microsurg 2010;2(2):58–61. [CrossRef]