Article published online: 2024-12-18

Comprehensive Inpatient Rehabilitation Protocol for Acquired Diaphragmatic Hernia Repair: A Case Report

Reema Mohan Athwale[1] Manish Prannath Shukla[1]

[1] Department of Cardiovascular and Respiratory Physiotherapy, MGM School of Physiotherapy, Chhatrapati Sambhajinagar, Maharashtra, India

Address for correspondence Dr Manish Prannath Shukla, Department of Cardiovascular and Respiratory Physiotherapy, Datta Meghe College of Physiotherapy, Nagpur 441110, Maharashtra, India (e-mail: manish.shukla20@gmail.com).

J Health Allied Sci[NU]

Abstract

This case report presents a comprehensive rehabilitation approach for a 32-year-old female patient who underwent diaphragmatic hernia repair. The rehabilitation protocol aimed to improve postoperative recovery, promote independence, and enhance the patient's quality of life. The study outlines a 2-week treatment plan with specific goals and interventions for each phase. Our findings reveal promising outcomes, demonstrating the positive impact of rehabilitation on postoperative recovery. The rehabilitation interventions not only contributed to enhanced diaphragmatic muscle mobility, vital parameters, chest expansion, pulmonary function, and respiratory muscle strength but also lead to improved breathing patterns. The outcomes of this study emphasize the crucial role of customized rehabilitation programs in maximizing respiratory function, fostering mobility, mitigating complications, and facilitating functional recovery. Through a comprehensive case report, we showcase the efficacy of integrating tailored rehabilitation strategies into the postoperative care paradigm in promoting overall recovery and elevating the well-being of individuals undergoing diaphragmatic hernia repair.

Keywords

- diaphragmatic hernia
- hernia rehabilitation
- traumatic acquired hernia

Introduction

A diaphragmatic hernia (DH) occurs when the diaphragm, the muscle separating the abdomen and chest cavity, develops a defect, allowing abdominal contents to protrude into the thoracic cavity.[1] While some cases are congenital, acquired DHs typically occur as a result of blunt or penetrating trauma, requiring careful detection and suspicion. The incidence of DH is estimated to be around 0.8 to 5 per 10,000 births.[2] Acquired DHs are primarily caused by trauma, which leads to increased pressure in the pleuroperitoneal region and the formation of anatomical defects in the diaphragm at weak fusion sites.[3] This allows the upper abdominal contents to herniate into the thoracic cavity.[4] The pathophysiology of this condition involves circulatory and respiratory depression due to impaired diaphragm function, compression of the lungs by abdominal contents in the chest, displacement of the mediastinum, and potential compromise to cardiac function.[5,6]

The research landscape surrounding rehabilitation strategies for acquired DH is relatively sparse, with limited studies exploring nonsurgical interventions. While surgical intervention remains the cornerstone in clinical practice for repairing acquired DHs, the current body of research primarily emphasizes operative techniques and outcomes. However, these surgeries can impact lung function and give rise to various complications, including reduced lung volume, decreased functional residual capacity, impaired clearance of mucus from the airways, and abnormalities in gas exchange.[7] Consequently, postoperative pulmonary complications can occur even after hernia repair. Delayed mobilization has been associated with an increased risk of these complications.[8] Additionally,

DOI https://doi.org/10.1055/s-0044-1800981.
ISSN 2582-4287.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

postthoracotomy pain syndrome and a decrease in range of motion and strength in the upper extremities on the affected side are commonly observed postoperative issues.[9] Limited attention has been directed toward investigating comprehensive rehabilitation strategies to optimize postoperative recovery. This gap in the literature underscores the need for a more nuanced understanding of nonsurgical interventions that can complement surgical approaches and address aspects such as respiratory function, mobility, and overall well-being.

To facilitate postoperative recovery, promote independence, and enhance the quality of life for patients undergoing traumatic DH repair, comprehensive inpatient rehabilitation is crucial. Therefore, this case report presents a comprehensive rehabilitation protocol developed for a patient undergoing repair of an acquired DH. The aim of this report is to outline a structured plan for the rehabilitation of acquired DH patients.

Case Presentation:

A 32-year-old woman, a homemaker, presented to a tertiary hospital with chief complaint of recurrent fever accompanied by chills. The febrile episodes were intermittent in nature and accompanied by additional symptoms such as episodes of nausea, vomiting, and a burning sensation during urination. The patient reported experiencing these symptoms for the past 4 months following a minor traumatic event. Despite being previously diagnosed with renal calculi and urinary bladder cystitis, her symptoms failed to improve with conservative medical management.

Upon admission on March 8, 2023, the patient underwent comprehensive radiographic and hematological investigations as part of the initial assessment. However, the persistent abdominal pain remained her primary concern. To further investigate her condition, a contrast-enhanced computed tomography (CECT) scan of the chest with high-resolution computed tomography (HRCT) was performed. The imaging findings unveiled a left-sided DH, wherein the stomach, spleen, pancreas, and a segment of the colon were identified as the herniated contents. The size of the defect in the diaphragm was measured at 7.1 cm, resulting in the compression collapse of the left lung and displacement of the mediastinum and heart toward the right side (►**Figs. 1** and **2**).

Consequently, the patient underwent DH repair utilizing a laparoscopic approach. However, due to the presence of adhesions hindering the complete reduction of the herniated contents, the surgical procedure had to be converted to an open subcostal incision. In the postoperative phase in the intensive care unit, the patient underwent uneventful extubation. Following extubation, she presented with tachycardia, tachypnea, and an abnormal breathing pattern. According to the documentation in the file, we found that despite these challenges, the patient remained conscious, alert, and responsive. Subsequently, the patient was closely monitored in the surgical intensive care unit (►**Fig. 3**), and an inpatient rehabilitation program was initiated after obtaining patient's informed consent starting from the second day postsurgery. Pertinent postoperative investigations were conducted to assess the patient's progress and recovery (►**Fig. 4**).

Outcome Measures

The study utilized various outcome measures, including the inch tape method to assess chest expansion, mobility evaluation of the diaphragm muscle, pulmonary function tests, strength assessment of respiratory muscles, Functional Independence Measure (FIM) scale for daily activity independence, and Abdominal Surgery Impact Scale (ASIS) for quality-of-life evaluation.

Assessment

►**Table 1** presents vital parameters and chest expansion assessments post-DH repair. Positive progress was observed: heart rate decreased from 124 to 92 bpm, respiratory rate reduced from 35 to 18 brpm, and oxygen saturation improved from 92 to 99%. The breathing pattern shifted, and chest expansion increased, indicating enhanced lung function. Mild asymmetry was noted on day 15.

►**Table 2** illustrates the outcomes of the diaphragm muscle manual examination on postoperative days 2 and 15. Initial limitations in movement and strength progressively improved by day 15, signifying enhanced diaphragmatic function and mobility.

►**Table 3** details the results of pulmonary function tests and respiratory muscle strength assessments on postoperative day 15, emphasizing rigorous precautions to ensure accuracy and patient safety. Findings include positive outcomes such as forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, vital capacity (VC), maximal inspiratory pressure (MIP), and maximal expiratory pressure (MEP), indicating improved respiratory function and muscle strength.

In this case report, the ASIS evaluated the patient's quality of life post-DH repair, while the FIM reflected a significant improvement from 47 to 78% in functional independence after rehabilitation.

Physical Therapy Rehabilitation

In week 1 of the rehabilitation protocol post-DH repair, a holistic approach was employed (►**Table 4**). Patient education about surgery and potential complications preceded rehabilitation, with baseline vital parameter recording on all postoperative days. Dyspnea evaluation through the modified Borg's scale before and after sessions played a crucial role in addressing respiratory challenges. Careful patient positioning, continuous vital sign monitoring, and meticulous incision site care demonstrated the commitment to patient well-being.

Emphasis on cleanliness and infection prevention was evident, with physical therapists wearing sterile gloves and using surgical gowns. Exercises were executed with smooth transitions, minimizing strain and ensuring optimal healing. Early rehabilitation goals, spanning from days 2 to 4, targeted

Fig. 1 High-resolution computed tomography (HRCT).

breathing pattern improvement, chest expansion, secretion mobilization, thoracic mobility, circulatory complication reduction, and posture maintenance.

In the subsequent days, from days 5 to 7, the focus shifted to mobility enhancement and functional capacity improvement. Tailored rehabilitation interventions were administered based on ongoing assessments, ensuring patient-specific care throughout recovery.

Week 2 extended the week 1 regimens and introduced new techniques such as scapular stability exercises and chest neuromuscular facilitation (►**Table 5**). From days 11 to 14, a strengthening program commenced, progressing from isometric to isotonic exercises targeting various muscle groups. Increased sitting and ambulation activities aimed at enhancing functional capacity and promoting independence.

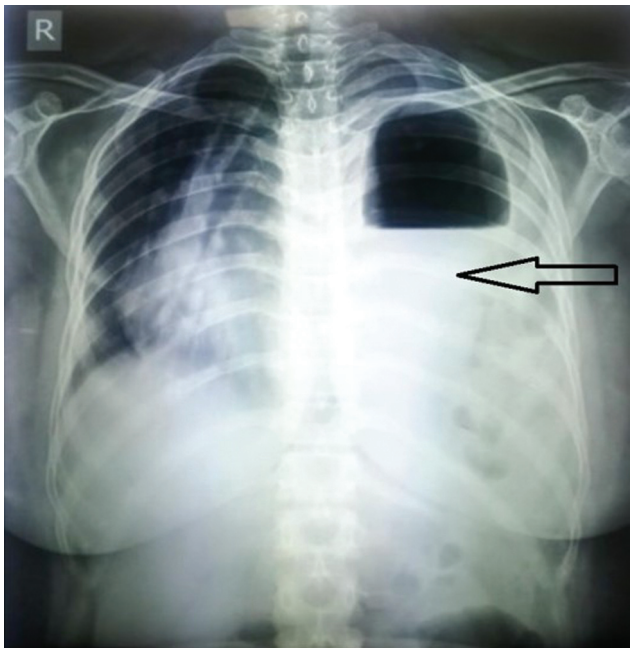

Fig. 2 Chest X-ray. *Compression collapse of the left lung.

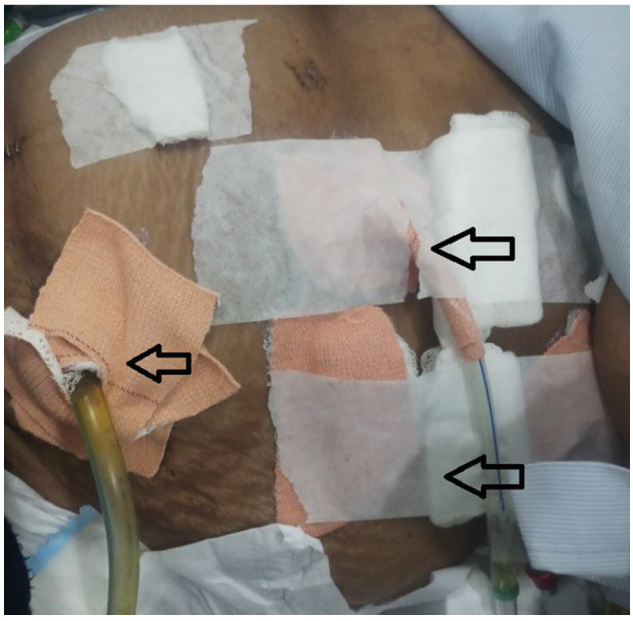

Fig. 3 Drain and incision site after operation.

Fig. 4 Drain and incision site at 1 week postoperatively.

The rehabilitation plan's adaptability, based on ongoing assessments and the patient's response, ensured a comprehensive recovery following DH repair, highlighting the commitment to individualized care and patient well-being.

Discussion

In this specific case report focusing on physical therapy rehabilitation for acquired DH, our primary goal was to address diaphragm mobility and recruitment, emphasizing pulmonary function and incorporating endurance and strength training for extremity muscles.

Our rehabilitation program aligned with recommendations from the European Society of Intensive Care Medicine, emphasizing the pivotal role of physical therapists in early mobilization and exercise prescription for critically ill patients.[10] Commencing with relaxation techniques and therapeutic positioning, our approach aimed to optimize diaphragmatic function and enhance respiratory muscle

Table 1 Vital parameters and chest expansion assessment

Vital parameters			
Parameters	**Postoperative day 2**	**Postoperative day 7**	**Postoperative day 15**
Heart rate	124 bpm	106 bpm	92 bpm
Respiratory rate	35 brpm	27 brpm	18 brpm
Oxygen saturation	92% with O_2 support via the venturi mask	96% with O_2 support via the nasal cannula	99% at room air
Pattern of breathing	Abdominothoracic	Abdominothoracic	Thoracoabdominal

Table 1 (*Continued*)

Vital parameters			
Parameters	**Postoperative day 2**	**Postoperative day 7**	**Postoperative day 15**
Chest expansion (inches)			
Axillary level	0.4	0.8	1
Nipple level	0.6	1	1.2
2 cm above the xiphisternum	1.4	1.8	2
Chest asymmetry	Asymmetrical	Asymmetrical	Mild asymmetry

Table 2 The diaphragm muscle manual examination

Evaluation areas	Postoperative day 2		Postoperative day 15	
	Right	Left	Right	Left
Costal movements	2	5	1	3
Anterior costal margin	2	5	1	3
Diaphragmatic domes	3	5	1	3
Posterolateral areas	2	5	1	3
Xiphoid costal area	Not applicable			
Medial pillar				
Lateral pillar				

Table 3 Pulmonary function test and respiratory muscle strength assessment

Parameters	Postoperative day 15
Pulmonary function test	
FEV1 (L)	2.19
FVC (L)	2.78
FEV1/FVC (L)	79
VC (%)	2.88
Respiratory muscle strength	
Maximal inspiratory pressure (MIP)	48 cm H_2O
Maximal expiratory pressure (MEP)	32 cm H_2O

Abbreviations: FEV1, forced expiratory volume in 1 second; FVC, forced vital capacity; VC, vital capacity.

Table 4 Postoperative rehabilitation protocol (week 1)

Goals	Protocol	Dosage/frequency (sets and repetitions)
Week 1 (postoperative days 2–7)		
Patient education	Patient and family education about the surgery and its complication	
Patient position	Patient positioning: head end elevated at 30 degrees	With monitoring vitals
To improve breathing pattern	Diaphragmatic breathing exercise	2 sets of 8–10 repetitions
To improve chest expansion	Self-assisted segmental chest expansion	2 sets of 8–10 repetitions
	Incentive spirometry	2 sets of 8–10 repetitions
To mobilize secretions	Active cycle of breathing technique	10–12 min
To improve mobility of thorax	Assisted thoracic mobility exercises paced with diaphragmatic breathing	2 sets of 8–10 repetitions
To reduce circulatory complications	Heel taps and heel raises	2 sets of 8–10 repetitions
	Active ROM exercises for bilateral Upper limb in the available pain free range	2 sets of 8–10 repetitions
	Ankle pumps and in bed heel slides	2 sets of 8–10 repetitions
To maintain correct posture	Postural correction exercise: neck stretches, shoulder bracing exercises	3 min
To improve functional capacity	Bedside sitting	15–30 min
	Bedside supported sit to stand	2 sets of 8–10 repetitions
	Bedside ambulation with support	3-4 min

Abbreviations: ROM, range of motion.

Table 5 Postoperative progressive rehabilitation protocol (week 2)

Goals	Progression protocol	Dosage/frequency (sets and repetitions)
Week 2 (postoperative days 8–14)		
To improve ROM	Active ROM exercises for bilateral upper limb in the available pain-free range	2 sets of 8–10 repetitions
	Scapular stability exercises	
To improve breathing pattern	Chest NFR: abdominal co-contraction	5–6 repetitions
To improve chest expansion	Segmental chest expansion: apical, lateral, and posterior	2 sets of 8–10 repetitions
	Incentive spirometry with holds	2 sets 8–10 repetitions with 2- to 5-s holds
To improve mobility of thorax	Thoracic mobility exercises paced with diaphragmatic breathing	2 sets of 8–10 repetitions
To maintain correct posture	Stretching of the pectoralis major and sternocleidomastoid muscles	2 sets 8–10 repetitions with 10- to 12-s holds
To increase muscle strength	Static abdominals: activation of transverses abdominis muscle	2 sets of 8–10 repetitions, 5- to 7-s holds
	Strengthening of muscles of the lower limb (isometric to isotonic in progression) Hip: flexors, extensors, adductors, and adductors Knee: flexors and extensors	2 sets of 8–10 repetitions
To improve functional capacity	Bedside sitting	30–50 min
	Spot marching	2 sets of 8–10 repetitions
	Bedside ambulation independently	1–2 laps of 20–30 m

Abbreviations: NFR, neurophysiological facilitation of respiration; ROM, range of Motion.

coordination. Specific diaphragmatic breathing exercises were employed to retrain altered postoperative breathing patterns, resulting in reduced respiratory rate and improved breathing depth.

The observed reduction in heart rate can likely be attributed to rhythmic and slow breathing techniques, known to impact cardiovascular parameters, particularly in hypertensive individuals. Engaging in deep and slow breathing practices enhances baroreflex sensitivity, contributing to efficient blood pressure control.[11] These techniques also reduce chemoreflex activation, regulating respiratory and cardiovascular functions.

Upon stabilizing vital signs, we progressed to mobilization activities, stressing the cardiopulmonary system to enhance overall cardiovascular fitness and respiratory function safely. In the second week, we introduced chest neuromuscular proprioceptive facilitation techniques, focusing on diaphragm recruitment and core muscle activation. Integrating proprioceptive neuromuscular facilitation (PNF) techniques through resistance training aimed to increase respiratory muscle strength and stimulate reflex respiratory movement responses.[12]

Our comprehensive multisystem approach, encompassing various interventions, likely played a crucial role in enhancing muscle strength and endurance. By engaging in exercises targeting diverse muscle groups, our strategy synergistically contributed to improved muscle recruitment patterns, ultimately leading to increased strength and endurance.

Throughout the program, we prioritized incision site care and infection prevention measures to ensure patient safety. While our structured treatment protocol provides a framework, individualized care and ongoing assessment remain crucial for tailoring the program to meet each patient's specific needs and ensuring successful outcomes. This case underscores the significance of a targeted and comprehensive rehabilitation approach in managing DH postsurgery.

Conclusion

The case report highlights the significance of a comprehensive rehabilitation program in the management of acquired DH. Physical therapy interventions play a crucial role in optimizing respiratory function, enhancing mobility, reducing complications, and promoting functional recovery.

Patient Consent for Publication

Informed consent was obtained from the patient for being included in the study.

Conflict of Interest

None declared.

References

1 Chandrasekharan PK, Rawat M, Madappa R, Rothstein DH, Lakshminrusimha S. Congenital diaphragmatic hernia: a review. Matern Health Neonatol Perinatol 2017;3:6

2 Katukuri GR, Madireddi J, Agarwal S, Kareem H, Devasia T. Delayed diagnosis of left-sided diaphragmatic hernia in an elderly adult with no history of trauma. J Clin Diagn Res 2016;10(04):PD04–PD05
3 Testini M, Girardi A, Isernia RM, et al. Correction to: emergency surgery due to diaphragmatic hernia: case series and review. World J Emerg Surg 2019;14:48
4 Cortes M, Tapuria N, Khorsandi SE, et al. Diaphragmatic hernia after liver transplantation in children: case series and review of the literature. Liver Transpl 2014;20(12):1429–1435
5 Reeve J. Physiotherapy interventions to prevent postoperative pulmonary complications following lung resection. What is the evidence? What is the practice?. N Z J Physiother 2008;36(03): 118–130
6 Wang Q, Liu Q, Zang J, Wang J, Chen J. Risk factors affecting postoperative pulmonary function in congenital diaphragmatic hernia. Ann Surg Treat Res 2020;98(04):206–213
7 Hanekom SD, Brooks D, Denehy L, et al. Reaching consensus on the physiotherapeutic management of patients following upper abdominal surgery: a pragmatic approach to interpret equivocal evidence. BMC Med Inform Decis Mak 2012;12:5
8 Haines KJ, Skinner EH, Berney SAustin Health POST Study Investigators. Association of postoperative pulmonary complications with delayed mobilisation following major abdominal surgery: an observational cohort study. Physiotherapy 2013;99 (02):119–125
9 Belda J, Cavalcanti M, Iglesias M, Gimferrer J, Torres A. Respiratory infections after lung cancer resection. Clin Pulm Med 2006;13 (01):8–16
10 Gosselink R, Bott J, Johnson M, et al. Physiotherapy for adult patients with critical illness: recommendations of the European Respiratory Society and European Society of Intensive Care Medicine Task Force on Physiotherapy for Critically Ill Patients. Intensive Care Med 2008;34(07):1188–1199
11 Joseph CN, Porta C, Casucci G, et al. Slow breathing improves arterial baroreflex sensitivity and decreases blood pressure in essential hypertension. Hypertension 2005;46(04):714–718
12 Zwoliński T, Wujtewicz M, Szamotulska J, et al. Feasibility of chest wall and diaphragm proprioceptive neuromuscular facilitation (PNF) techniques in mechanically ventilated patients. Int J Environ Res Public Health 2022;19(02):960

