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Original research article

THE EFFECT OF RESPIRATORY PHYSIOTHERAPY ON ATELECTASIS AND OXYGENATION IN POST-CARDIAC SURGERY PATIENTS

YOUSAF B[1*], HUSSAIN AS[2], RAFIQ K[3], SARWER AR[4], LATIF S[5], AYUB Z[6]

[1]*CCU, Sheikh Zayed Hospital, Lahore, Pakistan*
[2]*Department of Cardiac Surgery, Rehmatul-lil-Alameen Institute of Cardiology (RAIC), Lahore, Pakistan*
[3]*Ibn e Siena Hospital and Research Institute Multan, Pakistan*
[4]*Department of cardiac surgery, Punjab Institute of Cardiology (PIC), Lahore Pakistan, Lahore, Pakistan*
[5]*Basic Health Unit Khurita, AJK, Pakistan*
[6]*Satti Muhammad Lohsar Complex AJK, Pakistan*
**Correspondence author email address:* bilqeesyousaf96@gmail.com

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Abstract: *Post-operative pulmonary complications, particularly atelectasis, are common following cardiac surgery, contributing to prolonged recovery and increased morbidity. This study evaluates the effect of respiratory physiotherapy on atelectasis resolution and oxygenation in post-cardiac surgery patients in Pakistan.* ***Methods:*** *A prospective observational study was conducted at Sheikh Zayed Hospital, Lahore, from March to July 2024, involving 80 patients divided equally into an intervention group and a control group. The intervention group received standard care with respiratory physiotherapy, including deep breathing exercises, incentive spirometry, and early mobilization, while the control group received standard care alone. Primary outcomes included atelectasis resolution assessed via chest X-rays and oxygenation measured through arterial blood gas analysis. Secondary outcomes included pulmonary infection rates, ICU stay duration, and total hospital stay.* ***Results:*** *The intervention group demonstrated significantly improved atelectasis resolution scores by postoperative day 5 (1.3 ± 0.5 vs. 2.6 ± 0.8, $p < 0.001$) and enhanced oxygenation levels (PaO_2: 96.2 ± 7.3 vs. 86.9 ± 8.5 mmHg, $p < 0.001$) compared to the control group. Pulmonary infections were significantly lower in the intervention group (12.5% vs. 30%, $p < 0.05$), and ICU and hospital stays were reduced (ICU stay: 3.4 ± 1.1 vs. 4.9 ± 1.6 days, $p < 0.001$; hospital stay: 7.1 ± 2.2 vs. 9.3 ± 2.4 days, $p < 0.001$).* ***Conclusion:*** *Respiratory physiotherapy effectively improves atelectasis resolution, oxygenation, and recovery outcomes in post-cardiac surgery patients. Incorporating structured physiotherapy into routine care is essential for optimizing outcomes, particularly in resource-constrained settings like Pakistan.*

Keywords: Respiratory physiotherapy, Atelectasis, Oxygenation, Post-cardiac surgery, Pulmonary complications, Pakistan.

Introduction

Cardiac surgery, a critical intervention for various cardiovascular conditions, often leads to post-operative pulmonary complications, particularly atelectasis, which can significantly impair oxygenation and delay recovery. Atelectasis, defined as the partial or complete collapse of the lung or lung segments, is one of the most common respiratory complications after cardiac surgery, with an incidence ranging from 60% to 80% globally (1). This complication not only affects post-operative outcomes but also increases morbidity, hospital stays, and healthcare costs. These challenges are particularly pronounced in developing countries like Pakistan, where healthcare systems are burdened by limited resources, and the prevalence of risk factors such as smoking, obesity, and respiratory conditions remains high (2).

Respiratory physiotherapy has emerged as a vital component of post-operative care in mitigating pulmonary complications. Techniques such as deep breathing exercises, incentive spirometry, and early mobilization are known to improve lung expansion, reduce pulmonary infection rates, and enhance oxygenation (3). However, the integration of structured respiratory physiotherapy into routine post-operative care is often overlooked in resource-constrained settings like Pakistan (4). This oversight is due in part to the lack of trained professionals and standardized protocols, making it imperative to explore its potential benefits in local populations (5).

The Pakistani population presents unique challenges in the context of post-cardiac surgery recovery. High rates of smoking, environmental pollution, and delayed health-seeking behaviors contribute to compromised respiratory health in many patients (6). Moreover, the scarcity of physiotherapy services in public hospitals further exacerbates the risk of poor outcomes (7). Recent studies conducted in Pakistan and other developing countries have highlighted the urgent need for effective interventions to address post-operative pulmonary complications, yet limited research has specifically focused on the role of respiratory physiotherapy in this population (8).

This study aims to evaluate the effect of respiratory physiotherapy on atelectasis resolution and oxygenation in post-cardiac surgery patients in Pakistan. By providing evidence-based insights, this research seeks to emphasize the importance of incorporating structured respiratory physiotherapy into routine care protocols. The findings have the potential to guide healthcare providers in improving patient outcomes and optimizing resource utilization in a low-resource setting.

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Methodology

This prospective observational study was conducted at Sheikh Zayed Hospital, Lahore, over four months from March 2024 to July 2024. The study aimed to evaluate the effect of respiratory physiotherapy on atelectasis and oxygenation in post-cardiac surgery patients. A total of 80 patients were enrolled using non-probability consecutive sampling. Participants were divided equally into two groups: an intervention group, which received standard post-operative care along with respiratory physiotherapy, and a control group, which received standard post-operative care without respiratory physiotherapy.

The inclusion criteria for this study included adults aged 18 to 70 years undergoing elective cardiac surgery, who were hemodynamically stable within the first 24 hours post-surgery and capable of providing informed consent. Patients with pre-existing severe pulmonary conditions, such as chronic obstructive pulmonary disease or interstitial lung disease, those requiring re-intubation due to post-operative complications, or individuals unable to comply with the intervention protocol due to cognitive impairments were excluded.

Respiratory physiotherapy was initiated in the intervention group within 24 hours of surgery and included a structured regimen of deep breathing exercises performed every two hours during waking hours, incentive spirometry conducted 5–10 times per hour, and early mobilization involving gradual sitting, standing, and ambulation as tolerated. The control group received routine post-operative care, including nursing support, pain management, and oxygen supplementation when necessary.

Data collection included baseline demographic information and clinical outcomes. Atelectasis was evaluated using chest X-rays scored by two independent radiologists, while oxygenation was assessed through arterial partial pressure of oxygen (PaO2) measurements obtained via arterial blood gas analysis. Secondary outcomes included the incidence of pulmonary infections, duration of ICU stay, and total hospital stay.

The study protocol was approved by the Institutional Review Board of Sheikh Zayed Hospital, Lahore. Written informed consent was obtained from all participants, and patient confidentiality was maintained throughout the study. Data analysis was conducted using SPSS version 25. Continuous variables, such as age and PaO2 levels, were expressed as mean ± standard deviation and compared using independent t-tests. Categorical variables, such as gender and the incidence of pulmonary infections, were presented as frequencies and percentages and analyzed using chi-square tests. A p-value of less than 0.05 was considered statistically significant.

Results

The results of this study demonstrate the impact of respiratory physiotherapy on atelectasis and oxygenation in post-cardiac surgery patients. Table 1 presents the demographic and baseline characteristics of the 80 patients included in the study. Participants were evenly distributed across the intervention and control groups, ensuring comparable baseline characteristics. The mean age was 56 ± 9 years, with a predominance of male patients (62.5%).

Table 1: Demographic and Baseline Characteristics of Participants

Variable	Intervention Group (n=40)	Control Group (n=40)	p-value
Age (mean ± SD, years)	55.8 ± 8.7	56.2 ± 9.3	0.81
Gender (Male/Female)	25/15	25/15	1.00
BMI (mean ± SD, kg/m²)	26.7 ± 3.2	26.4 ± 3.5	0.74
Smoking History (Yes/No)	16/24	18/22	0.67
Preoperative EF (%)	55.5 ± 5.6	55.0 ± 6.2	0.69

The resolution of atelectasis was evaluated through chest X-ray findings. Patients in the intervention group showed significantly improved atelectasis scores by postoperative day 5 compared to the control group.Table 2 presents the atelectasis scores at various postoperative time points. A statistically significant improvement in atelectasis resolution was observed in the intervention group, particularly by postoperative days 3 and 5.

Table 2: Comparison of Atelectasis Scores Between Groups

Day Post-Surgery	Intervention Group (Mean ± SD)	Control Group (Mean ± SD)	p-value
Day 1	3.6 ± 0.9	3.7 ± 0.8	0.63
Day 3	2.1 ± 0.7	3.1 ± 0.9	<0.001
Day 5	1.3 ± 0.5	2.6 ± 0.8	<0.001

Oxygenation levels were assessed using arterial blood gas (ABG) analysis. The intervention group demonstrated significantly higher partial pressure of oxygen (PaO2) levels compared to the control group. Table 3 shows the oxygenation improvement over five days post-surgery. The intervention group exhibited significant enhancement in PaO2 levels by days 3 and 5.

Table 3: Changes in Oxygenation Parameters (PaO2) Post-Surgery

Day Post-Surgery	Intervention Group (Mean ± SD, mmHg)	Control Group (Mean ± SD, mmHg)	p-value
Day 1	79.5 ± 10.2	80.2 ± 9.9	0.68
Day 3	91.3 ± 8.7	84.6 ± 9.8	<0.01

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Day 5	96.2 ± 7.3	86.9 ± 8.5	<0.001

Postoperative complications, including pulmonary infections and ICU stay duration, were assessed. The intervention group experienced fewer complications and shorter hospital stays. Table 4 demonstrates the incidence of postoperative complications and length of hospital stay. The intervention group showed a marked reduction in complications and hospital stay duration.

Table 4: Postoperative Complications and Length of Stay

Variable	Intervention Group (n=40)	Control Group (n=40)	p-value
Pulmonary Infections (n, %)	5 (12.5%)	12 (30%)	<0.05
ICU Stay (days, mean ± SD)	3.4 ± 1.1	4.9 ± 1.6	<0.001
Total Hospital Stay (days)	7.1 ± 2.2	9.3 ± 2.4	<0.001

Discussion

The findings of this study highlight the significant impact of respiratory physiotherapy on improving atelectasis resolution and oxygenation in post-cardiac surgery patients. These results are consistent with previously published studies and provide further evidence of the effectiveness of structured physiotherapy interventions in reducing post-operative pulmonary complications.

In our study, patients who received respiratory physiotherapy showed a statistically significant improvement in atelectasis resolution compared to the control group, as evidenced by better chest X-ray scores on postoperative days 3 and 5. These findings align with the results of Kheradmand et al. (9), who reported that respiratory physiotherapy significantly reduces pulmonary complications, including atelectasis, in post-cardiac surgery patients. Similarly, Restrepo et al. (10) highlighted the role of incentive spirometry and deep breathing exercises in improving lung re-expansion and reducing atelectasis rates. The improvement in oxygenation observed in our intervention group, measured by increased PaO2 levels, supports the findings of Williams et al. (11), who demonstrated that breathing exercises can enhance arterial oxygenation by improving lung ventilation and perfusion. The significant increase in oxygenation by postoperative day 5 in our study is comparable to the outcomes reported by Canet and Gallart (12), who found that respiratory physiotherapy significantly accelerates recovery of pulmonary function.

Additionally, the reduction in pulmonary infections and shorter ICU and hospital stays in the intervention group in our study corroborate the findings of Ghani et al. (13), who emphasized the cost-effectiveness of integrating respiratory physiotherapy into routine care for improving patient outcomes and reducing healthcare burden. The lower incidence of pulmonary infections observed in our study is particularly relevant to resource-limited settings like Pakistan, where high rates of smoking and environmental pollution pose significant challenges (14).

Our findings also highlight the importance of early mobilization, which was a key component of the physiotherapy protocol. Early mobilization has been shown to reduce the risk of post-operative complications, including venous thromboembolism and pneumonia, as reported by Khawar et al. (15). This underscores the need for a multidisciplinary approach in managing post-cardiac surgery patients, particularly in low-resource settings.

However, some limitations of this study should be noted. While our findings demonstrate the efficacy of respiratory physiotherapy, the study was conducted in a single center, which may limit generalizability. Additionally, long-term follow-up was not included to assess the sustained benefits of physiotherapy. Future studies should focus on multicenter trials with larger sample sizes and long-term evaluations to provide more comprehensive insights.

In conclusion, the results of this study strongly support the incorporation of respiratory physiotherapy into standard post-operative care for cardiac surgery patients in Pakistan. By demonstrating significant improvements in atelectasis resolution, oxygenation, and reduced complications, this study highlights the potential of physiotherapy to improve patient outcomes, reduce healthcare costs, and address the challenges posed by resource constraints in developing countries.

Conclusion

This study demonstrates that respiratory physiotherapy significantly improves atelectasis resolution and oxygenation in post-cardiac surgery patients. The intervention reduced pulmonary complications, shortened ICU and hospital stays, and enhanced recovery outcomes. These findings underscore the importance of integrating structured respiratory physiotherapy into routine post-operative care, particularly in resource-limited settings like Pakistan, to improve patient outcomes and optimize healthcare resources.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.
Approved by the department Concerned. (IRBEC-SHZH-023222/23)

Consent for publication
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Conflict of interest

The authors declared an absence of conflict of interest.

Authors Contribution

BILQEES YOUSAF

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Final Approval of version, Data collection, study design
AGHA SAJJAD HUSSAIN
Revisiting Critically, literature review, drafting
KHURRAM RAFIQ
Data Analysis, literature search
ABDUL REHMAN SARWER
Drafting, study design
SHAHID LATIF & ZAWAR AYUB (Medical Officer)
Concept & Design of Study, literature review

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