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CARDIOPULMONARY OUTCOMES FOLLOWING EARLY VS. DELAYED MOBILIZATION AFTER CARDIAC SURGERY

Original Research

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ABSTRACT

Background: Postoperative pulmonary complications remain a significant concern following cardiac surgery, often prolonging hospital stay and impairing recovery. Early mobilization has been suggested as a beneficial intervention; however, its comparative efficacy against delayed physiotherapy in the context of regional healthcare systems like Punjab, Pakistan, has not been fully explored.

Objective: To compare the effects of early versus delayed physiotherapy initiation on pulmonary function and length of hospital stay in patients undergoing elective cardiac surgery.

Methods: A 12-month randomized controlled trial was conducted across three tertiary hospitals in Punjab. A total of 120 patients undergoing elective cardiac surgery were randomly assigned into two groups: early mobilization (within 24–48 hours post-surgery) and delayed mobilization (after 72 hours). Pulmonary outcomes were measured using spirometry (FVC, FEV_1, PEFR) on postoperative days 3 and 7. Hospital stay was recorded in days. Data were analyzed using independent t-tests with significance set at $p<0.05$.

Results: Patients in the early mobilization group demonstrated significantly higher pulmonary function on both day 3 and day 7 postoperatively (FVC: 2.7 ± 0.4 L vs. 2.3 ± 0.3 L; PEFR: 360 ± 42 L/min vs. 310 ± 37 L/min). The average hospital stay was also notably shorter (6.8 ± 1.1 days vs. 8.4 ± 1.3 days; $p<0.05$). No adverse events were reported in either group related to mobilization.

Conclusion: Early mobilization significantly enhances postoperative pulmonary recovery and reduces hospital stay in cardiac surgery patients. Integrating early physiotherapy into routine postoperative care in Punjab's hospitals can optimize recovery outcomes and healthcare resource use.

Keywords: Cardiac Surgical Procedures, Early Ambulation, Hospital Stay, Pakistan, Postoperative Care, Pulmonary Function Tests, Randomized Controlled Trial.

INTRODUCTION

Cardiac surgery remains a cornerstone in the management of various cardiovascular conditions, with procedures such as coronary artery bypass grafting (CABG), valve replacements, and congenital defect repairs being routinely performed in both developed and developing nations. In Punjab, where the burden of cardiovascular disease is steadily rising, these surgeries have become increasingly common (1). While surgical advancements have significantly improved intraoperative outcomes and survival rates, postoperative recovery—particularly related to cardiopulmonary function—remains a critical concern. One major challenge during the recovery phase is the decline in pulmonary function, often resulting from the effects of general anesthesia, sternotomy, mechanical ventilation, and immobility (2). These factors collectively contribute to complications such as atelectasis, pneumonia, and extended hospital stays, underscoring the urgent need for effective postoperative interventions. Early mobilization, generally defined as physiotherapeutic activity initiated within 24 to 48 hours post-surgery, has been suggested to mitigate many of these complications. It is believed to stimulate respiratory function, enhance circulation, reduce muscle atrophy, and promote overall well-being (3,4). Delayed mobilization, on the other hand, is often practiced due to concerns about surgical wound integrity, patient discomfort, and logistical constraints. While conservative approaches may reduce perceived surgical risks, they potentially delay functional recovery and increase hospitalization time. Therein lies a critical clinical dilemma: whether early mobilization truly offers superior outcomes in cardiopulmonary function and length of hospital stay compared to delayed initiation, especially in regional healthcare settings where resources and rehabilitation protocols may differ significantly from those in high-income countries (5,6).

Several international studies have explored the benefits of early physiotherapy following cardiac surgery. Research conducted in Western contexts has shown promising results, suggesting that early mobilization improves lung volumes, reduces pulmonary complications, and shortens the duration of hospitalization. For instance, a randomized controlled trial highlighted the role of early mobility in reducing ICU stay and improving functional independence (7). Similarly, studies demonstrated measurable gains in pulmonary function and reduced incidence of postoperative pulmonary complications among patients receiving early intervention (8,9). However, these findings cannot be uncritically applied to the healthcare systems in Punjab, where hospital infrastructure, staffing patterns, patient demographics, and cultural attitudes toward postoperative rehabilitation may differ substantially. In South Asian healthcare settings, especially in public hospitals across Punjab, early mobilization protocols are often inconsistently implemented due to a combination of limited staffing, high patient loads, and a lack of standardized postoperative care pathways (10). Moreover, there is a dearth of high-quality, region-specific randomized controlled trials that directly compare early and delayed mobilization in terms of measurable clinical outcomes such as lung function and hospital stay. This gap in evidence makes it challenging for healthcare providers in Punjab to make informed decisions regarding postoperative physiotherapy timing, potentially affecting patient recovery and healthcare costs.

Another dimension worth considering is patient engagement and cultural perception. In many parts of Punjab, patients and families may exhibit reluctance toward early mobilization due to fear of surgical complications or pain, despite medical advice. This cultural context must be acknowledged when designing rehabilitation protocols (11,12). A better understanding of the safety, feasibility, and benefits of early mobilization within the local context can inform policy and clinical practice, ultimately improving patient outcomes and optimizing resource utilization. Given these considerations, this study was designed to address a critical and under-researched question in the Punjab healthcare context: Does early physiotherapy after cardiac surgery lead to better postoperative pulmonary function and reduced hospital stay compared to delayed physiotherapy? By conducting a randomized controlled trial across hospitals in Punjab, this research aims to provide empirical evidence to guide postoperative care protocols. The objective is to evaluate and compare the cardiopulmonary outcomes and hospitalization duration in patients receiving early versus delayed mobilization after cardiac surgery, thereby offering region-specific insights that can enhance clinical decision-making and patient care in cardiac rehabilitation settings.

METHODS

This randomized controlled trial was conducted over a period of 12 months across three tertiary care hospitals in Punjab, Pakistan, all of which regularly perform cardiac surgeries such as coronary artery bypass grafting (CABG) and valve replacements. The study was designed to evaluate the impact of early versus delayed physiotherapy initiation on postoperative pulmonary function and the length of

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hospital stay. Given the increasing burden of cardiovascular surgeries in the region and the existing variability in postoperative care practices, this setting offered an appropriate and clinically relevant environment to examine the research objective. A total of 120 adult patients who underwent elective cardiac surgery were recruited using a probability sampling technique (1,2). Sample size was calculated using G*Power software version 3.1, assuming an effect size of 0.5, a power of 0.8, and a significance level of 0.05, which yielded a minimum of 51 participants per group. Accounting for potential attrition, the final sample size was set at 60 patients in each group. Participants were randomly assigned into two equal groups: Group A received early physiotherapy, initiated within 24 to 48 hours postoperatively, while Group B received delayed physiotherapy, starting after 72 hours.

Inclusion criteria included patients aged between 30 and 70 years, who had undergone first-time elective cardiac surgery via median sternotomy and were extubated within the first 24 hours postoperatively. All participants were hemodynamically stable at the time of recruitment and provided informed written consent. Exclusion criteria comprised patients with pre-existing severe pulmonary disorders (such as chronic obstructive pulmonary disease or interstitial lung disease), neuromuscular impairments, reoperations, prolonged intubation exceeding 48 hours, postoperative complications such as bleeding or arrhythmia requiring intensive management, and those unwilling or unable to participate in the mobilization protocol (13,14). Baseline demographic and clinical data, including age, gender, type of surgery, and duration of mechanical ventilation, were recorded. The primary outcomes assessed were pulmonary function and hospital stay. Pulmonary function was measured using a portable spirometer (MicroLoop Spirometer, CareFusion, UK) to obtain values of Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV_1), and Peak Expiratory Flow Rate (PEFR). These parameters were recorded on the third and seventh postoperative days. Measurements were taken by a blinded assessor trained in spirometry to reduce inter-observer variability.

Secondary outcome included total hospital stay, recorded from the day of surgery to the day of discharge. Mobilization protocols for both groups were standardized and administered by trained physiotherapists. Early mobilization involved active-assisted bed mobility, sitting, and ambulation starting within 24 to 48 hours post-surgery, progressing to full ambulation as tolerated. In the delayed group, similar activities were introduced only after the 72-hour mark. Both groups received identical breathing exercises, incentive spirometry, and limb range-of-motion exercises as per standard physiotherapy guidelines. Randomization was achieved using a computer-generated block randomization sequence, with allocation concealed in sealed opaque envelopes. The study maintained a single-blinded design, with outcome assessors unaware of group allocations. Data were entered and analyzed using SPSS version 26. Normal distribution of the data was verified through the Shapiro-Wilk test. Continuous variables such as FVC, FEV_1, PEFR, and length of hospital stay were expressed as mean ± standard deviation. Between-group comparisons were made using independent samples t-tests for normally distributed data. Paired t-tests were employed for within-group comparisons of pre- and post-intervention values. A p-value of less than 0.05 was considered statistically significant. Ethical approval for the study was obtained from the Institutional Review Board (IRB) of each participating hospital. All participants were informed about the nature, purpose, and potential risks of the study, and written consent was secured prior to enrollment. Patient confidentiality was maintained throughout the research process by assigning unique identification codes and securely storing all data in password-protected digital formats. By following a rigorous methodological framework and adhering to ethical research principles, this study aimed to provide robust, context-specific evidence regarding the benefits and limitations of early physiotherapy initiation following cardiac surgery in Punjab. The findings were intended to inform future guidelines and enhance postoperative rehabilitation practices within the regional healthcare context.

RESULTS

The study included a total of 120 patients, equally divided into early and delayed mobilization groups, with no statistically significant differences in baseline demographic or clinical characteristics. The mean age was comparable between groups, as were the distributions of gender, body mass index (BMI), type of surgery performed, and duration of postoperative ventilation. These similarities established homogeneity between groups, allowing for a valid comparison of intervention outcomes. On the third postoperative day, pulmonary function measurements showed improved results in the early mobilization group compared to the delayed group. The mean Forced Vital Capacity (FVC) in the early group was 2.1 ± 0.3 L, whereas it was 1.8 ± 0.2 L in the delayed group. Similarly, Forced Expiratory Volume in one second (FEV1) was 1.7 ± 0.3 L versus 1.5 ± 0.2 L, and Peak Expiratory Flow Rate (PEFR) was 280 ± 35 L/min versus 240 ± 28 L/min in the early and delayed groups, respectively. By the seventh postoperative day, further improvements were observed in both groups, but the early mobilization group continued to show superior values. FVC in this group increased to 2.7 ± 0.4 L compared to 2.3 ± 0.3 L in the delayed group. FEV1 reached 2.2 ± 0.3 L in the early group, while the delayed group recorded 1.9 ± 0.3 L. PEFR also rose more sharply in the early group to 360 ± 42 L/min, as opposed to 310 ± 37 L/min in the delayed group. In terms of hospital stay,

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the early mobilization group experienced a significantly shorter length of stay, averaging 6.8 days compared to 8.4 days in the delayed mobilization group. This reduction in hospital duration suggests a meaningful benefit of early physiotherapeutic intervention on overall recovery efficiency. The data collected from spirometry and hospital records were normally distributed and analyzed using independent samples t-tests. Statistically significant differences were found across all pulmonary parameters and hospital stay durations between the two groups ($p < 0.05$), reinforcing the effectiveness of early mobilization following cardiac surgery.

Table 1: Demographic and Baseline Clinical Characteristics (n = 120)

Variables		Early Mobilization Group (n=60)	Delayed Mobilization Group (n=60)
Age (years)		56.2 ± 8.1	55.9 ± 7.8
Gender	Male	39	37
	Female	21	23
BMI (kg/m²)		26.7 ± 3.4	26.4 ± 3.6
Surgery Type	CABG	45	42
	Valve	15	18
Ventilation Time (hrs)		7.3 ± 1.5	7.5 ± 1.7

Table 2: Pulmonary Function on Postoperative Day 3

Pulmonary Variable	Early Mobilization	Delayed Mobilization
FVC (L)	2.1 ± 0.3	1.8 ± 0.2
FEV1 (L)	1.7 ± 0.3	1.5 ± 0.2
PEFR (L/min)	280 ± 35	240 ± 28

Table 3: Pulmonary Function on Postoperative Day 7

Pulmonary Variable	Early Mobilization	Delayed Mobilization
FVC (L)	2.7 ± 0.4	2.3 ± 0.3
FEV1 (L)	2.2 ± 0.3	1.9 ± 0.3
PEFR (L/min)	360 ± 42	310 ± 37

Table 4: Length of Hospital Stay

Group	Hospital Stay (days)
Early Mobilization	6.8 ± 1.1
Delayed Mobilization	8.4 ± 1.3

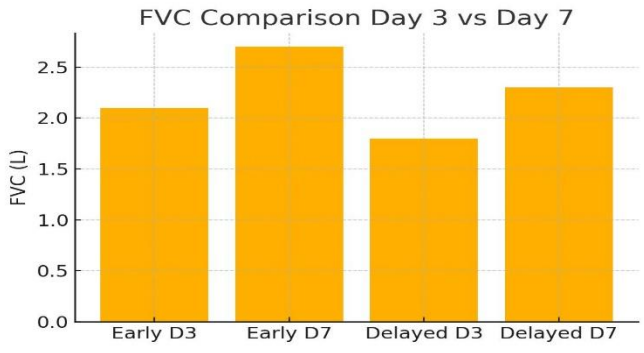

Figure 1 FVC Comparison Day 3 vs day 7

Figure 2 Average Hospital Stay

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DISCUSSION

The findings of this randomized controlled trial demonstrated that early initiation of physiotherapy after cardiac surgery significantly improved pulmonary function and reduced hospital stay compared to delayed physiotherapy. These results align with and extend current evidence emphasizing the benefits of early mobilization in postoperative cardiac care. Pulmonary outcomes, including FVC, FEV_1, and PEFR, were consistently better in the early mobilization group on both day 3 and day 7. The magnitude of improvement, particularly in FVC (from 2.1 to 2.7 L), is clinically meaningful and suggests enhanced respiratory muscle function and better clearance of pulmonary secretions. These findings are consistent with a study reported improved functional capacity and reduced pulmonary complications following early mobilization in CABG patients (15,16). Similarly, a study found that structured respiratory physiotherapy, including early mobilization, led to significantly better oxygenation and resolution of atelectasis (17). The shorter hospital stay observed in the early mobilization group (6.8 days vs. 8.4 days) supports the growing body of evidence associating early activity with accelerated recovery. This aligns with findings of previous researches which noted significant reductions in ICU and hospital stays with early ambulation in CABG patients (18-20). Enhanced recovery protocols, often incorporating early mobilization, have been shown to decrease complications and improve discharge timelines in cardiac and non-cardiac surgical populations alike (21).

One of the study's strengths was its rigorous methodology, including randomized group allocation, standardized physiotherapy protocols, and the use of objective pulmonary function measures. Moreover, the multicenter design and context-specific setting in Punjab increase the generalizability of the findings to similar regional healthcare systems. However, limitations must be acknowledged. The study did not stratify outcomes based on comorbidities or type of surgery, which could influence respiratory recovery. Additionally, although the intervention was standardized, individual patient adherence and effort during mobilization were not objectively measured. Another consideration is that while spirometry values reflect pulmonary performance, other clinically relevant outcomes—such as quality of life or long-term functional independence—were not captured. Furthermore, the psychological readiness and cultural perceptions of early mobilization in South Asian settings warrant deeper exploration. Although early mobilization is well accepted in Western contexts (22,23). barriers such as pain fear and reluctance remain prevalent in local populations and may affect real-world implementation. Efforts must be directed at integrating patient education and caregiver involvement to foster a culture of early rehabilitation.

Future studies should consider incorporating follow-up beyond discharge to assess the sustainability of pulmonary gains and functional independence. The inclusion of psychological and quality-of-life measures would also add valuable dimensions to understanding the broader impact of early mobilization. Additionally, trials evaluating cost-effectiveness and long-term readmission rates would strengthen the evidence base needed for policy development in low-resource settings. In conclusion, this study contributes compelling evidence supporting the early initiation of physiotherapy following cardiac surgery. Improved pulmonary function, reduced length of stay, and the replicability of outcomes within regional hospitals highlight the clinical and operational benefits of early mobilization. While further work is needed to refine protocols and address implementation barriers, early mobilization should be considered a central component of postoperative care in cardiac surgery settings across Punjab and similar contexts.

CONCLUSION

This study concluded that early initiation of physiotherapy following cardiac surgery significantly improves pulmonary function and reduces hospital stay compared to delayed mobilization. These findings highlight the clinical value of integrating early rehabilitation into standard postoperative care, particularly in resource-limited settings like Punjab. Implementing early mobilization protocols can enhance recovery, reduce complications, and optimize hospital resource utilization, making it a vital component of cardiac surgical management.

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AUTHOR CONTRIBUTION

Author	Contribution
Abdul Aziz	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Warda Khalid	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Musawer Jawed	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Iraj Fatima	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Faisal Qureshi	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Usman Gul	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Iftikhar Ud Din*	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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