

## Early Physiotherapy in a Post-Coronary Artery Bypass Grafting Patient with Hypertension and Diabetes: A Case Report

Pandu Tirto Hutomo<sup>1</sup>, Tiara Fatmarizka<sup>2</sup>, Purnomo Gani<sup>3</sup>, Diani Qomara Dewi<sup>4</sup>

<sup>1,2,4</sup>Physiotherapy Professional Program, Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Indonesia

<sup>3</sup>Physiotherapist Practitioner, Dr. Kariadi General Hospital, Semarang, Indonesia

Corresponding author:

Name: Pandu Tirto Hutomo

E-mail: [j130255082@student.ums.ac.id](mailto:j130255082@student.ums.ac.id)

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### Abstract

**Background:** Coronary artery disease is a leading cause of morbidity requiring Coronary Artery Bypass Grafting (CABG). Patients undergoing CABG commonly present with comorbidities such as hypertension and type 2 diabetes mellitus, which may impair postoperative recovery, particularly pulmonary function and functional capacity.

**Objective:** To evaluate the clinical effects of early physiotherapy on oxygen saturation, thoracic expansion, pain, and functional recovery in a post-CABG patient with multiple comorbidities.

**Methods:** This study was conducted as a case report following CARE guidelines. A 53-year-old male with triple-vessel coronary artery disease underwent CABG and had comorbid hypertension, type 2 diabetes mellitus, and dyslipidemia. Early physiotherapy was initiated during the acute postoperative phase, including diaphragmatic breathing, pursed-lip breathing, active range of motion exercises, and progressive mobilization. Outcomes were assessed at three time points (T1–T3), including oxygen saturation (SpO<sub>2</sub>), thoracic expansion, pain using the Numeric Rating Scale (NRS), and vital signs.

**Results:** SpO<sub>2</sub> increased from 95% to 99% ( $\Delta+4\%$ ). Thoracic expansion improved from 1 cm to 2 cm at the axillary level. Pain during movement decreased from NRS 4 to 2 ( $\Delta-2$ ), while resting pain decreased from 2 to 1. Vital signs remained stable, and no adverse events were observed.

**Conclusion:** Early physiotherapy in a post-CABG patient with hypertension and diabetes demonstrated improvements in pulmonary function, pain reduction, and functional capacity. Structured and individualized rehabilitation appears safe and beneficial in the acute postoperative phase.

### Keywords

Coronary Artery Bypass; Early Ambulation; Diabetes Mellitus; Hypertension; Physiotherapy

### Introduction

Coronary artery disease (CAD) remains a leading cause of morbidity and mortality worldwide, placing a substantial burden on healthcare systems and patient quality of life. Surgical intervention through Coronary Artery Bypass Grafting (CABG) is widely performed to restore myocardial perfusion in patients with advanced or multi-vessel disease.<sup>1</sup> Despite its effectiveness in improving survival and reducing cardiac symptoms, postoperative recovery following CABG is often complicated by functional impairments, particularly in pulmonary function and physical capacity.<sup>1</sup>

A significant proportion of patients undergoing CABG present with comorbid conditions, most notably hypertension and type 2 diabetes mellitus. These comorbidities are not only risk factors for CAD but also contribute to poorer postoperative outcomes due to their impact on vascular function, systemic inflammation, and tissue healing.<sup>2</sup> Patients with diabetes, for instance, frequently exhibit microvascular dysfunction and impaired oxygen delivery, while hypertension is associated with endothelial dysfunction and altered hemodynamic responses.<sup>3</sup> The coexistence of these conditions increases the risk of postoperative complications and may prolong recovery time, thereby necessitating a more comprehensive and individualized rehabilitation approach.<sup>2,3</sup>

In the early postoperative phase, patients commonly experience reduced pulmonary function characterized by dyspnea, decreased thoracic expansion, impaired ventilation, and secretion retention.<sup>4</sup> These impairments are primarily attributed to surgical trauma, pain from sternotomy, reduced mobility, and the effects of anesthesia. Without appropriate intervention, such conditions may lead to pulmonary complications, delayed recovery, and decreased functional independence.<sup>4</sup> Therefore, early rehabilitation strategies targeting respiratory function and mobility are essential components of postoperative care.

Physiotherapy interventions, particularly breathing exercises and early mobilization, have been shown to play a crucial role in improving pulmonary mechanics and functional outcomes after CABG. Breathing techniques such as diaphragmatic breathing and pursed-lip breathing can enhance alveolar ventilation, improve oxygenation, and reduce the work of breathing.<sup>4</sup> Additionally, structured cardiac rehabilitation programs incorporating physical exercise have demonstrated improvements in functional capacity, cardiovascular endurance, and overall quality of life.<sup>5</sup> Early mobilization, in particular, is recognized as a key intervention in preventing deconditioning, reducing postoperative complications, and facilitating faster recovery.<sup>5,6</sup>

Beyond physiological benefits, breathing exercises may also positively influence psychological outcomes. Evidence suggests that controlled breathing techniques can reduce anxiety, improve sleep quality, and enhance overall patient well-being following cardiac surgery.<sup>7</sup> These findings highlight the multidimensional benefits of physiotherapy interventions, encompassing both physical and psychological domains of recovery.

However, despite the established benefits of physiotherapy in post-CABG populations, most existing studies primarily focus on general patient populations or on outcomes observed during the subacute to chronic phases of rehabilitation.<sup>5</sup> There remains limited evidence specifically addressing the effectiveness of early physiotherapy interventions during the acute postoperative phase

in patients with complex comorbidities such as hypertension and diabetes mellitus. This gap is clinically significant, as these patients represent a high-risk group with unique physiological challenges that may influence their response to rehabilitation.

The presence of diabetes and hypertension further complicates the rehabilitation process due to impaired microcirculation, increased inflammatory responses, and altered metabolic regulation.<sup>9,10</sup> These factors can delay tissue healing, reduce exercise tolerance, and increase the risk of adverse events during physical activity. Consequently, physiotherapy interventions in this population must be carefully tailored, with close monitoring of vital signs, glucose levels, and patient tolerance to ensure safety and effectiveness.<sup>8</sup>

Given these considerations, there is a need for clinically grounded evidence that illustrates the application and outcomes of early physiotherapy in patients with multiple comorbidities following CABG. Case reports provide valuable insights into individualized clinical management, particularly in complex cases where standardized protocols may not fully capture patient-specific needs.

Therefore, this case report aims to evaluate the clinical effects of early physiotherapy interventions on oxygen saturation (SpO<sub>2</sub>), thoracic expansion, pain, and functional status in a post-CABG patient with comorbid hypertension and type 2 diabetes mellitus. By presenting detailed clinical observations and outcomes, this study seeks to contribute to the existing body of knowledge and provide practical implications for physiotherapy management in high-risk cardiac patients during the acute postoperative phase.

**Methods**

This study was designed as a single-patient case report following the CARE (CAse REport) guidelines to ensure completeness, transparency, and clinical relevance in reporting. Written informed consent was obtained from the patient for participation and publication of anonymized clinical data. All procedures were conducted in accordance with ethical principles for human research, and patient confidentiality was strictly maintained.

The subject was a 53-year-old male diagnosed with coronary artery disease involving triple-vessel disease and left main involvement (CAD 3VD + LM disease), who underwent Coronary Artery Bypass Grafting (CABG) on September 16, 2025. The patient had multiple comorbidities, including hypertension, type 2 diabetes mellitus, dyslipidemia, and a history of smoking. Anthropometric measurements indicated a height of 175 cm, body weight of 75 kg, and a body mass index of 24.5 kg/m<sup>2</sup>. Prior to surgery, the patient reported a two-year history of chest pain exacerbated by physical exertion and relieved by rest, accompanied by dyspnea.

Postoperatively, the patient was admitted to the intensive cardiac care unit (ICCU) for five days before being transferred to the general ward. Initial clinical assessment in the early postoperative phase revealed chest pain localized at the sternotomy site during movement, reduced thoracic expansion, dyspnea, early fatigue, and limited functional mobility, particularly in bed mobility and transfers. Respiratory rhythm was regular at rest, with no evidence of wheezing or peripheral edema. Functional status assessment using the Barthel Index yielded a score of 6, indicating severe dependence. Laboratory findings showed a hemoglobin level of 10.8 g/dL. Chest radiography demonstrated left ventricular cardiomegaly, persistent bronchopneumonia infiltrates, and increasing right pleural effusion.

Clinical outcomes were evaluated at three time points: T1 (early postoperative phase), T2 (rehabilitation phase), and T3 (final evaluation). The primary outcomes included oxygen saturation (SpO<sub>2</sub>), thoracic expansion, pain intensity, and vital signs. Vital signs consisted of blood pressure, heart rate, and mean arterial pressure (MAP), measured using calibrated hospital-grade monitoring devices to ensure accuracy and reliability.

Pain intensity was assessed using the Numeric Rating Scale (NRS), a validated and reliable instrument widely used in clinical settings, with reported validity coefficients exceeding 0.8 and good responsiveness to changes in clinical pain status. Thoracic expansion was measured using a standard measuring tape at three anatomical levels: axillary, nipple line (papilla mammae), and xiphoid process. This method has demonstrated acceptable intra-rater and inter-rater reliability (intraclass correlation coefficient >0.80), although measurement consistency depends on examiner technique. Oxygen saturation (SpO<sub>2</sub>) was continuously monitored using pulse oximetry, which is considered a standard non-invasive method for assessing peripheral oxygenation.

To ensure a clear understanding of the patient’s clinical progression and the sequence of interventions, data collection was structured across predefined time points representing key phases of recovery, as summarized in Table 1. This timeline captures the patient’s clinical condition, physiotherapy interventions, and observed outcomes from the preoperative stage to the final evaluation. This structured presentation facilitates reproducibility and provides a concise overview of the clinical course.

**Table 1.** Timeline of Clinical Condition, Intervention, and Outcomes

| Time Point                     | Clinical Condition and Assessment  | Intervention   | Outcome  |
|--------------------------------|--|--|--|
| T0 (Preoperative Phase)        | Diagnosis of coronary artery disease with comorbid hypertension and type 2 diabetes mellitus                                       | Preoperative preparation                             | Indication for CABG established  |
| T1 (Early Postoperative Phase) | Chest pain, dyspnea, reduced thoracic expansion; chest radiograph showed cardiomegaly, pulmonary infiltrates, and pleural effusion | Breathing exercises and positioning                  | Persistent dyspnea and limited mobility  |
| T2 (Rehabilitation Phase)      | Clinical condition stabilized; monitoring of SpO <sub>2</sub> , pain, and thoracic expansion                                       | Breathing exercises and early mobilization           | Increased SpO <sub>2</sub> and reduced pain (NRS 4→2)                                      |
| T3 (Final Evaluation Phase)    | Improved activity tolerance  | Breathing exercises, standing, and marching in place | Increased thoracic expansion (1→2 cm), improved pulmonary function and functional activity |

The physiotherapy intervention was administered during the acute postoperative phase (phase I cardiac rehabilitation) using the FITT (Frequency, Intensity, Time, Type) principle to ensure a structured and individualized approach. The intervention consisted of three main components.

Breathing exercises were performed 5–10 times per day with submaximal intensity based on patient tolerance, for 10–15 minutes per session. The techniques included diaphragmatic breathing and pursed-lip breathing aimed at improving lung expansion, enhancing oxygenation, and reducing the work of breathing. The intervention was progressively modified by incorporating active upper limb movements, such as slow arm elevation and abduction, to facilitate thoracic expansion.

Range of motion (ROM) exercises were conducted 2–3 times daily with low intensity, ensuring movements remained within a pain-free range. Each session lasted approximately 10–15 minutes and involved active movements of both upper and lower extremities to prevent joint stiffness and improve peripheral circulation.

Mobilization and transfer training were implemented twice daily, with session durations ranging from 5 to 10 minutes depending on patient tolerance and continuous monitoring of vital signs. The progression of mobilization followed a stepwise approach: lateral positioning on day one, sitting at the edge of the bed on day two, standing on day three, and progressing to marching

in place as part of early ambulation. The progression was adjusted based on clinical stability and signs of intolerance, including increased dyspnea, chest pain, or significant changes in vital parameters.

Throughout the intervention period, patient safety was prioritized through continuous monitoring of physiological responses, including SpO<sub>2</sub>, blood pressure, and heart rate. The intervention was modified or paused if any adverse signs or symptoms were observed. No adverse events were reported during the intervention period.

Data analysis was conducted descriptively, given the nature of a single-case design. Changes in clinical parameters across the three time points (T1, T2, and T3) were analyzed by comparing pre- and post-intervention values. The results were presented in tabular form and supported by narrative descriptions to identify trends and clinical improvements over time. This approach is consistent with case report methodology, which emphasizes individual clinical interpretation rather than statistical inference.

To enhance clarity in data presentation, the main outcome data are summarized in tables (Table 1–Table 4), which describe changes in vital signs, pulmonary function, thoracic expansion, and pain scores. Each table is introduced in the Results section to ensure coherence between narrative and quantitative findings.

**Results**

This case report aimed to evaluate the effects of early physiotherapy on oxygen saturation (SpO<sub>2</sub>), thoracic expansion, pain, and overall clinical status in a post-CABG patient with comorbid hypertension and type 2 diabetes mellitus. Clinical outcomes were assessed at three time points: T1 (early postoperative phase), T2 (rehabilitation phase), and T3 (final evaluation). The results are presented to demonstrate temporal changes following the intervention.

To illustrate the sequence of interventions and corresponding clinical progression, the patient’s condition, physiotherapy management, and observed outcomes across different recovery phases are summarized in Table 2. This structured presentation emphasizes the temporal relationship between intervention and clinical response, facilitating clarity and reproducibility.

**Table 2.** Clinical Progression Following Physiotherapy Intervention

| Time Point                     | Patient Condition  | Physiotherapy Intervention                           | Clinical Outcome   |
|--------------------------------|--|--|--|
| T0 (Preoperative Phase)        | Diagnosed with coronary artery disease with hypertension and type 2 diabetes mellitus  | Preoperative preparation                             | Indication for CABG established  |
| T1 (Early Postoperative Phase) | Chest pain, dyspnea, reduced thoracic expansion; chest radiograph showed cardiomegaly, pulmonary infiltrates, and pleural effusion | Breathing exercises and positioning                  | Dyspnea persisted; mobility remained limited   |
| T2 (Rehabilitation Phase)      | Clinical condition stabilized; monitored SpO <sub>2</sub> , pain, and thoracic expansion   | Breathing exercises combined with early mobilization | Increased SpO <sub>2</sub> ; reduced pain (NRS 4→2)  |
| T3 (Final Evaluation Phase)    | Improved activity tolerance  | Breathing exercises, standing, and marching in place | Increased thoracic expansion (1→2 cm); improved pulmonary function and functional activity |

To quantitatively describe the physiological response to intervention, changes in vital signs and pulmonary function parameters are summarized in Table 3.

**Table 3.** Changes in Vital Signs and Pulmonary Function Across Time Points

| Parameter                                | T1 Pre                       | T1 Post                      | T2 Pre                       | T2 Post                             | T3 Pre                       | T3 Post                        |
|--|------------------------------|------------------------------|------------------------------|-------------------------------------|------------------------------|--------------------------------|
| Blood Pressure (mmHg)                    | 111/59                       | 122/58                       | 104/62                       | 123/57                              | 110/75                       | 126/63                         |
| Mean Arterial Pressure (mmHg)            | 76                           | 79                           | 76                           | 75                                  | 87                           | 83                             |
| Oxygen Saturation (SpO <sub>2</sub> , %) | 95                           | 96                           | 96                           | 99                                  | 99                           | 99                             |
| Incentive Spirometry                     | Red indicator fully elevated | Red indicator fully elevated | Red indicator fully elevated | Yellow indicator partially elevated | Red indicator fully elevated | Yellow indicator half elevated |

Note: SpO<sub>2</sub> showed a progressive increase, reaching 99% at the final evaluation.

As shown in Table 3, systolic blood pressure demonstrated a consistent increase following intervention across all time points, from 111/59 mmHg to 122/58 mmHg at T1, 104/62 mmHg to 123/57 mmHg at T2, and 110/75 mmHg to 126/63 mmHg at T3. In contrast, diastolic blood pressure showed a slight decreasing trend after intervention. Mean arterial pressure (MAP) exhibited minor fluctuations, increasing at T1 (76 to 79 mmHg) and slightly decreasing at T2 (76 to 75 mmHg) and T3 (87 to 83 mmHg), while remaining within clinically acceptable limits throughout.

Oxygen saturation (SpO<sub>2</sub>) showed a progressive improvement over time, increasing from 95% at baseline to 96% and reaching 99% at final evaluation. This trend indicates enhanced pulmonary ventilation and gas exchange following physiotherapy intervention. Additionally, incentive spirometry demonstrated gradual improvement in inspiratory capacity, reflected by progression from activation of the red indicator alone at T1 to partial elevation of the yellow indicator at T2 and further improvement at T3. These findings collectively suggest improved respiratory function during the intervention period. To further evaluate respiratory mechanics, thoracic expansion was measured at three anatomical levels, as presented in Table 4.

**Table 4.** Changes in Thoracic Expansion

| Measurement Site               | T1      | Δ | T2      | Δ | T3      | Δ |
|--------------------------------|---------|---|---------|---|---------|---|
| Axillary Level                 | 102–103 | 1 | 102–104 | 2 | 102–104 | 2 |
| Nipple Line (Papilla Mammarum) | 103–104 | 1 | 103–104 | 1 | 103–104 | 1 |
| Xiphoid Process                | 100–101 | 1 | 100–101 | 1 | 100–101 | 1 |

Note: Δ represents the difference between maximal inspiration and expiration.

As presented in Table 3, thoracic expansion showed a measurable improvement, particularly at the axillary level. At T1, all measurement sites demonstrated an expansion difference of 1 cm. At T2, axillary expansion increased to 2 cm, while the papilla mammae and xiphoid levels remained unchanged at 1 cm. This improvement was maintained at T3, indicating sustained enhancement of upper thoracic mobility. The localized increase at the axillary level suggests a more pronounced recovery in the upper lung regions, which are commonly affected in postoperative conditions. Pain intensity was assessed using the Numeric Rating Scale (NRS), with results summarized in Table 5.

**Table 5.** Pain Intensity Using Numeric Rating Scale (NRS)

| Condition       | T1 | T2 | T3 |
|-----------------|----|----|----|
| At Rest         | 2  | 2  | 1  |
| During Movement | 4  | 2  | 2  |

Note: The Numeric Rating Scale (NRS) ranges from 0 to 10, where higher scores indicate greater pain intensity.

As shown in Table 4, pain intensity decreased progressively throughout the intervention period. At T1, pain was reported as 2 at rest and 4 during movement. At T2, movement-related pain decreased to 2, while resting pain remained unchanged. At T3, resting pain further decreased to 1, while movement-related pain remained stable at 2. These findings indicate a gradual reduction in pain, particularly at rest, reflecting improved patient comfort and recovery status.

In addition to objective clinical parameters, patient-reported outcomes indicated improvements in perceived comfort and functional ability. The patient reported reduced dyspnea and increased confidence in performing movements, particularly during mobilization activities. Functional progression was observed from initial dependence in bed mobility to the ability to sit, stand, and perform marching in place by the final evaluation phase.

Importantly, no adverse events were observed during the intervention period. Vital signs remained stable, and the patient tolerated all physiotherapy interventions well. This finding supports the safety and feasibility of early physiotherapy in the acute postoperative phase, even in patients with multiple comorbidities.

Overall, the results demonstrate consistent improvements across multiple clinical domains, including oxygenation, thoracic expansion, pain reduction, and functional mobility. These findings align with the study objective and provide preliminary evidence supporting the effectiveness of early physiotherapy in complex post-CABG patients.

## Discussion

This case report demonstrates that early physiotherapy interventions, including breathing exercises, range of motion training, and progressive mobilization, were associated with clinically meaningful improvements in oxygenation, thoracic expansion, pain reduction, and functional mobility in a post-CABG patient with comorbid hypertension and type 2 diabetes mellitus. Notably, these improvements were observed within the acute postoperative phase, a period often characterized by physiological instability and increased risk of complications. The findings provide preliminary evidence supporting the feasibility and potential effectiveness of early physiotherapy in high-risk cardiac patients with complex comorbidities.

The observed improvement in oxygen saturation (SpO<sub>2</sub>) from 95% to 99% suggests enhanced pulmonary ventilation and gas exchange following intervention. This finding is consistent with previous studies indicating that breathing exercises, particularly diaphragmatic breathing and pursed-lip breathing, improve alveolar ventilation and oxygenation in post-CABG patients.<sup>4</sup> These techniques facilitate more efficient diaphragmatic movement, promote basal lung expansion, and reduce the work of breathing. Furthermore, pursed-lip breathing contributes to maintaining positive end-expiratory pressure, thereby preventing alveolar collapse and improving ventilation-perfusion matching.<sup>4,9</sup> In addition, early mobilization may have contributed to improved pulmonary perfusion through increased cardiac output and redistribution of blood flow, further enhancing gas exchange efficiency.<sup>5</sup>

Thoracic expansion improved from 1 cm to 2 cm, particularly at the axillary level, indicating enhanced chest wall mobility and respiratory muscle function. Postoperative limitations in thoracic expansion are commonly associated with pain from sternotomy, reduced respiratory muscle activation, and protective breathing patterns.<sup>10</sup> The improvement observed in this case likely reflects the combined effects of breathing exercises and active upper limb movements, which facilitate thoracic mobility and improve lung compliance.<sup>11</sup> Although the increase was more pronounced in the upper thoracic region, this pattern is clinically relevant, as postoperative pulmonary impairment often disproportionately affects upper lung ventilation due to shallow breathing patterns.<sup>12</sup>

Pain reduction, particularly during movement (NRS 4 to 2), represents another important outcome. Pain following CABG, especially at the sternotomy site, is a major barrier to effective breathing and mobilization. The reduction in pain observed in this study may be explained by several mechanisms. Early mobilization and light physical activity can enhance circulation and reduce muscle stiffness, while also activating endogenous analgesic pathways.<sup>13</sup> Additionally, breathing exercises may contribute to relaxation and reduced sympathetic activation, thereby indirectly influencing pain perception.<sup>14</sup> These findings align with previous evidence demonstrating that early rehabilitation interventions can reduce postoperative pain and improve patient comfort.<sup>6</sup>

Importantly, vital signs remained stable throughout the intervention period, indicating that early physiotherapy was well tolerated despite the presence of hypertension and diabetes mellitus. This is a critical finding, as patients with these comorbidities are at increased risk of hemodynamic instability and vascular dysfunction.<sup>3,15</sup> The absence of adverse events suggests that carefully monitored, low-to-moderate intensity physiotherapy interventions can be safely implemented even in high-risk populations.<sup>16</sup> This observation is consistent with current cardiac rehabilitation guidelines, which emphasize individualized exercise prescription and close monitoring to ensure patient safety.<sup>8</sup>

From a broader perspective, the functional improvements observed in this patient, including progression from bed mobility to standing and marching in place, highlight the importance of early mobilization in preventing deconditioning and promoting recovery.<sup>17</sup> Early mobilization has been consistently associated with improved functional outcomes, reduced hospital length of stay, and lower incidence of postoperative complications.<sup>18</sup> In this case, gradual progression based on patient tolerance appears to have facilitated functional recovery without compromising safety.

This study also contributes to the existing literature by addressing a notable gap regarding the application of early physiotherapy in patients with multiple comorbidities. Most prior studies have focused on general post-CABG populations or on rehabilitation during subacute and chronic phases.<sup>19</sup> In contrast, this case demonstrates that meaningful clinical improvements can be achieved even during the acute phase in patients with complex clinical profiles. Given that diabetes and hypertension are associated with impaired microcirculation, chronic inflammation, and delayed tissue healing, the positive response observed in this case is clinically significant and suggests that early intervention may help mitigate these adverse effects.<sup>20</sup>

However, the findings of this study should be interpreted with caution due to several limitations. First, as a single-case report, the results cannot be generalized to broader populations. The absence of a control group also limits the ability to attribute observed improvements solely to the physiotherapy intervention. Other factors, including pharmacological treatment, glycemic control, and standard postoperative care, may have contributed to the observed outcomes. Second, some outcome measures, such as thoracic expansion, rely on manual measurement techniques that are subject to examiner variability, despite reported acceptable reliability. Third, the use of incentive spirometry without quantitative recording limits the objectivity of respiratory function assessment. Additionally, the absence of standardized functional outcome measures, such as the 6-minute walk test (6MWT), restricts comprehensive evaluation of functional capacity.

Despite these limitations, this case report provides valuable clinical insights into the implementation of early physiotherapy in a high-risk postoperative population. The structured application of the FITT principle, combined with continuous monitoring and individualized progression, appears to be a key factor in achieving positive outcomes. These findings support the integration of early physiotherapy into standard postoperative care protocols for CABG patients, particularly those with comorbid conditions.

Future research should focus on higher-level study designs, such as randomized controlled trials, to establish the efficacy and safety of early physiotherapy in similar populations. The inclusion of objective outcome measures, such as spirometry,  $VO_2$ max, and functional performance tests, would further strengthen the evidence base. Additionally, studies exploring optimal timing, intensity, and progression of interventions in patients with multiple comorbidities are warranted to inform clinical guidelines.

In conclusion, this study provides preliminary evidence that early physiotherapy is both feasible and beneficial in improving pulmonary function, reducing pain, and enhancing functional recovery in post-CABG patients with hypertension and diabetes mellitus. While further research is needed, these findings underscore the importance of early, structured, and individualized rehabilitation strategies in optimizing postoperative outcomes in complex cardiac patients.

## Conclusion

This case report demonstrates that early physiotherapy intervention in a post-CABG patient with comorbid hypertension and type 2 diabetes mellitus was associated with improvements in oxygen saturation, thoracic expansion, pain reduction, and functional mobility during the acute postoperative phase. These findings directly address the study objective, indicating that early rehabilitation can produce measurable clinical benefits even in patients with complex cardiovascular and metabolic conditions.

From a clinical perspective, the implementation of structured physiotherapy based on breathing exercises, active mobilization, and gradual progression according to patient tolerance appears to be safe and feasible when accompanied by appropriate monitoring of vital signs. The stability of hemodynamic parameters and absence of adverse events further support the applicability of early physiotherapy in similar high-risk populations.

The findings highlight the importance of integrating physiotherapy into standard postoperative care for CABG patients, particularly those with comorbidities that may delay recovery. Early intervention may contribute to improved pulmonary function, reduced postoperative complications, and enhanced functional independence.

However, given the single-case design, the results should be interpreted with caution. Further research using more robust study designs, such as randomized controlled trials, is recommended to confirm these findings and establish optimal intervention protocols. Future studies should also incorporate objective functional outcome measures to strengthen the evidence base for early physiotherapy in post-CABG patients.

## Author Contribution

Pandu Tirto Hutomo Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing Original Draft

Tiara Fatmarizka Methodology, Validation, Writing Review and Editing

Purnomo Gani Supervision, Resources, Project Administration, Writing Review and Editing

Diani Qomara Dewi Data Curation, Visualization, Writing Review and Editing

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## Conflict of Interest Statement

The authors declare no conflict of interest.

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## Ethics Statement

This study was conducted in accordance with ethical standards for human research. Written informed consent was obtained from the patient for participation and publication of anonymized clinical data.

Catatan: Nomor ethical approval institusi belum tercantum dalam naskah asli. Jika tersedia, sebaiknya ditambahkan untuk memenuhi standar jurnal internasional.

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