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Total Intravenous Anesthesia for Coronary Artery Bypass Grafting: A Case Report of Successful Hemodynamic Management and Early Recovery

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ABSTRACT
Coronary artery bypass grafting (CABG) is a complex cardiac surgical procedure that requires precise anesthetic management to maintain hemodynamic stability and support optimal postoperative recovery. Total intravenous anesthesia (TIVA) has emerged as an alternative anesthetic technique in cardiac surgery due to its advantages in anesthetic titration, hemodynamic control, and facilitation of fast-track recovery protocols. This case report aimed to describe the application of TIVA in a high-risk CABG patient and evaluate its effectiveness in achieving intraoperative stability and early postoperative recovery. A case report was conducted involving a 66-year-old male patient with three-vessel coronary artery disease who underwent CABG at the National Cardiovascular Center Harapan Kita, Jakarta. Clinical data were collected from preoperative assessments, intraoperative anesthesia records, hemodynamic monitoring parameters, and postoperative intensive care management in accordance with the CARE guidelines. The patient received TIVA using propofol, sufentanil, and rocuronium, supported by multimodal monitoring, including the Bispectral Index (BIS), Near-Infrared Spectroscopy (NIRS), arterial line monitoring, and central venous catheter monitoring. The results demonstrated stable intraoperative hemodynamic conditions with appropriate vasoactive support using dobutamine and nitroglycerin. The patient successfully underwent early extubation eight hours after surgery, with acceptable postoperative laboratory parameters and no significant anesthetic complications. In conclusion, TIVA combined with comprehensive hemodynamic monitoring and fast-track protocols provided effective anesthetic management for CABG, supporting cardiovascular stability and early recovery. Further studies involving larger patient populations are required to confirm its broader clinical benefits.

INTRODUCTION

Coronary artery disease (CAD) is one of the leading causes of morbidity and mortality worldwide, including in Indonesia (Arsyad et al., 2025; Harmadha et al., 2023; Hartopo et al., 2023; Mahmuda et al., 2021; Muharram et al., 2024; Qalby et al., 2024). Coronary artery bypass grafting (CABG) is a myocardial revascularization procedure indicated for patients with multivessel CAD, particularly when percutaneous coronary intervention is not feasible or is considered suboptimal. The procedure involves creating new blood flow pathways to ischemic myocardium using grafts obtained from the internal mammary artery or saphenous vein.

Anesthetic management in CABG presents unique challenges because patients commonly have compromised cardiovascular conditions, including ventricular dysfunction, pulmonary hypertension, and an increased risk of arrhythmias (Al-Ghamdi, 2017; Holmes et al., 2025; Luxford & Bassin, 2017; Montrief et al., 2018; Okolo et al., 2025; Thunberg et al., 2013). The selection of appropriate anesthetic techniques and agents is crucial for minimizing intraoperative hemodynamic disturbances, protecting the myocardium from ischemia-reperfusion injury, and facilitating rapid postoperative recovery. The primary goals of anesthesia in CABG are to maintain the balance between myocardial oxygen supply and demand, prevent further ischemic events, and preserve hemodynamic stability throughout the surgical procedure.

Historically, volatile anesthesia using inhalational agents such as isoflurane, sevoflurane, and desflurane has been widely used in cardiac surgery, with proposed cardioprotective effects through mechanisms associated with ischemic preconditioning (Fazekas et al., 2026; Guerrero-Orriach et al., 2022; Qin & Zhou, 2023; Schneck & Perry, 2024; Torre & Pirri, 2026). However, over recent decades, total intravenous anesthesia (TIVA) has emerged as an increasingly recognized alternative approach for anesthetic management in CABG surgery. TIVA uses a combination of intravenous agents, including propofol, opioids (such as remifentanil, sufentanil, or fentanyl), and neuromuscular blocking agents for anesthesia induction and maintenance without the use of volatile anesthetic agents.

Propofol, as the primary component of TIVA, has a favorable pharmacokinetic profile characterized by rapid onset, predictable duration of action, and smooth recovery with minimal residual sedative effects. In the context of CABG, propofol also demonstrates antioxidant and anti-inflammatory properties that may provide additional protection against ischemia-reperfusion injury. Opioids such as sufentanil and remifentanil provide potent analgesia and attenuate the neuroendocrine stress response to surgical stimulation, which is particularly important during sternotomy and cardiac manipulation.

One of the primary advantages of TIVA in CABG is its ability to support fast-track protocols, including early extubation (typically within 4–8 hours postoperatively) and earlier transfer from the intensive care unit (ICU). These protocols have been associated with reduced ICU length of stay, healthcare costs, and complications related to prolonged mechanical ventilation without increasing the risk of postoperative complications. In this context, TIVA using short-acting agents allows more precise dose adjustment, faster and more predictable recovery of consciousness, and effective pain management.

Although several earlier studies reported potential cardioprotective effects of volatile anesthesia through anesthetic preconditioning mechanisms, recent meta-analyses have not demonstrated significant differences in mortality or major postoperative complications between TIVA and volatile anesthesia in CABG patients. Xiao et al. (2019), in an evaluation of 74 randomized controlled trials (RCTs) involving more than 11,000 patients, concluded that neither anesthetic technique showed consistent clinical superiority regarding major cardiovascular outcomes. These findings support the selection of TIVA based on individualized clinical considerations, including patient characteristics, institutional protocols, and anesthesiologist expertise.

Comprehensive hemodynamic monitoring remains an essential component of anesthesia management in CABG, regardless of the selected anesthetic technique. The use of anesthetic depth monitoring devices, such as the Bispectral Index (BIS), enables more accurate titration of anesthetic agents and helps avoid excessive or insufficient anesthesia depth, both of which may negatively affect clinical outcomes. Near-Infrared Spectroscopy (NIRS) for cerebral oxygen saturation monitoring has also become increasingly recognized as a valuable tool for detecting cerebral hypoperfusion, particularly during cardiopulmonary bypass (CPB) or in patients at increased risk of neurological complications.

This case report describes the clinical application of TIVA in a 66-year-old male patient with three-vessel CAD who underwent CABG at the National Cardiovascular Center Harapan Kita, Jakarta. This case provides insights into the selection and titration of intravenous anesthetic agents, hemodynamic monitoring strategies, perioperative vasoactive agent administration, and implementation of fast-track recovery protocols in major cardiac surgery. The aim of this case report was to document the successful application of a TIVA approach in a high-risk CABG patient and contribute to the growing evidence supporting the use of TIVA in cardiovascular anesthesia practice in Indonesia.

METHOD

This case report was prepared based on clinical data from a patient who underwent CABG surgery at the National Cardiovascular Center Harapan Kita, Jakarta, Indonesia. The report followed the CARE guidelines for clinical case reporting. Written informed consent was obtained from the patient and family members for the publication of the case, including relevant clinical information, diagnostic findings, and intraoperative data.

Data Collection

Clinical data were collected prospectively from the patient's medical records, encompassing: (1) preoperative history-taking and physical examination; (2) serial laboratory investigation results; (3) cardiological examination results including ECG, chest X-ray, transthoracic echocardiography (TTE), and coronary angiography; (4) intraoperative anesthesia records including drug dosages, hemodynamic parameters, and clinical events; and (5) postoperative ICU care records until the patient was transferred to a general ward.

Anesthesia Protocol

The anesthetic technique employed was total intravenous anesthesia (TIVA) with the following components:

Premedication was administered with intravenous midazolam 5 mg in the preoperative preparation room for anxiolytic and anterograde amnesia effects. Anesthesia induction was performed with intravenous sufentanil 25 mcg as an opioid analgesic agent, intravenous propofol 50 mg as a hypnotic agent, and intravenous rocuronium 50 mg as a muscle relaxant to facilitate endotracheal intubation. Intubation was performed using a standard-sized endotracheal tube (ETT), and ETT position was confirmed by auscultation and capnography.

Anesthesia maintenance was carried out with continuous infusions of propofol 200 mg/hour, sufentanil 12 mcg/hour, and rocuronium 6 mg/hour via syringe pump. Anesthetic depth was monitored using a BIS monitor with a target value of 25–40. Mechanical ventilation was delivered in volume control (VC) mode with a tidal volume of 450 ml, respiratory rate of 12 breaths/minute, PEEP of 5 cmH_2O, and FiO_2 of 60%.

Intraoperative Monitoring

Comprehensive hemodynamic monitoring was performed throughout the entire intraoperative period, including: BIS monitor for anesthetic depth, NIRS for cerebral oxygen saturation, pulse oximetry (SpO_2), continuous electrocardiogram (ECG), invasive blood pressure measurement via arterial line, and central venous pressure monitoring via central venous catheter (CVC). A 7-F CVC was inserted into the right subclavian vein, and an 8.5-F side port was placed in the right internal jugular vein as additional vascular access. Serial arterial blood gas analyses were performed throughout the procedure to monitor acid-base status, oxygenation, ventilation, electrolytes, and lactate levels.

Hemodynamic Management

To support cardiac function and maintain hemodynamic stability during the procedure, dobutamine was administered at a dose of 3–5 mcg/kg/minute as an inotropic agent, and

nitroglycerin at a dose of 0.5 mcg/kg/minute as a coronary vasodilator to optimize myocardial perfusion. Both vasoactive agents were administered via continuous infusion using syringe pumps and titrated according to the patient's hemodynamic response.

Postoperative Management and Fast-Track Protocol

Postoperatively, the patient was transferred to the ICU and managed on a ventilator in VC mode (tidal volume 450 ml, respiratory rate 12 breaths/minute, PEEP 5 cmH_2O, FiO_2 60%). Postoperative analgesia was provided via morphine infusion at 20 mcg/kg/hour. Extubation criteria included: stable hemodynamics, adequate level of consciousness, ability to breathe spontaneously with adequate tidal volume, and laboratory results (particularly arterial blood gas analysis) within acceptable limits. The extubation target was 8 hours postoperatively in accordance with the institutional fast-track protocol.

Table 1. Anesthetic Agents and Vasoactive Drugs Used

Anesthetic Agent / Drug	Dose	Purpose
Propofol	200 mg/hour (maintenance), 50 mg (induction)	Hypnotic/sedation; anesthesia maintenance
Sufentanil	25 mcg (induction), 12 mcg/hour (maintenance)	Opioid analgesia; stress response reduction
Rocuronium	50 mg (induction), 6 mg/hour (maintenance)	Muscle relaxation; facilitation of intubation & ventilation
Midazolam	5 mg (premedication)	Anxiolytic and preoperative amnesia
Dobutamine	3–5 mcg/kg/min	Inotropic support; enhancement of cardiac output
Nitroglycerin	0.5 mcg/kg/min	Coronary vasodilation; optimization of myocardial perfusion
Morphine	20 mcg/kg/hour	Postoperative analgesia in ICU

Table 2. Comprehensive Intraoperative Monitoring Parameters

Monitoring Parameter	Purpose	Notes
Bispectral Index (BIS)	Anesthetic depth	Target 25–40
NIRS (Near-Infrared Spectroscopy)	Cerebral oxygen saturation	Early detection of cerebral hypoperfusion
Pulse Oximetry (SpO_2)	Peripheral oxygen saturation	Continuous monitoring
Electrocardiogram (ECG)	Cardiac rhythm and function	Detection of arrhythmias and ischemia
Arterial Line	Continuous invasive blood pressure	Real-time response to interventions
Central Venous Catheter (CVC)	Central venous pressure & vascular access	Vasoactive drug delivery and volume monitoring
Serial Arterial Blood Gas Analysis	pH, PaO_2, $PaCO_2$, lactate, electrolytes	Guide for ventilation and metabolic management

RESULTS AND DISCUSSION

Case Report

A 66 year-old male patient presented with a history of recurrent chest pain since 1 year ago and worsened with activity such as walking long distances or going up and down stairs and radiating to the back. The pain reduced with rest or took sublingual medication. No history of hypertension, diabetes melitus, stroke, allergies or asthma were reported. History of smoking was present, however the patient ceased smoking since 10 years ago.

Physical examinations were unremarkable with stable vital signs (Blood pressure 129/69 mmHg, heart rate 60x/mins, regular, respiratory rate 18x/mins, oxygen saturation at 99% room air). Airway was clear with no obstructions with the ability to open the mouth with three fingers and Mallampati grade II. Cervical motion was clear with no restriction. with pulmonary and cardiac examinations were clear. It is known that the patient's height is 161 cm and weight 64,58 kg.

The laboratory result on 30th July 2024 showed a normal blood test result with hemoglobin 13,3 g/dL, hematocrit 39,1%, leukocyte 8.340/µL, dan thrombocytes 346.000/µL. Coagulation panel revealed normal results (PT 10,3 seconds, APTT 25,1 seconds, and INR 0,95). Liver function was within normal limit (SGOT 19 U/L and SGPT 18 U/L). Kidney function were within normal limits (ureum 31,2 mg/dL, creatinin 1,04 mg/dL, and eGFR 79 mL/min/1.73m2). Electrolyte panel were unremarkable (natrium 140 mmol/L, kalium 3,9 mmol/L, and chloride 110 mmol/L). Random blood glucose was at 90 mg/dL.

Inflammatory markers were PCT 0,04 ng/mL and CRP 2 mg/L. HBsAg test were negative. Serial laboratory examinations were performed and the result was within normal limit. ECG results a sinus normorhythm. However, chest x-ray on 30th July 2024 revealed a cardiomegaly. The patient then underwent a coronary angiography on 25th June 2024 and the results demonstrated a three-vessel coronary artery disease (CAD 3VD) with significant lesions in the right coronary artery (RCA), left anterior descending artery (LAD), and left circumflex artery (LCx). There was complete occlusion of the proximal RCA with collateral flow from the conus artery to the distal RCA.

Transthoracic echocardiography (TTE) performed on 15th July 2024 showed goof left ventricular systolic function with an ejection fraction of 67%. The left ventricle was normal in size with concentric remodeling. Left ventricular diastolic function was normal. The right ventricle was normal in size and function. The left and right atria were normal in size. The heart valves were structurally normal with mild tricuspid regurgitation. No intracardiac masses or thrombi were found. The pericardium was normal. The probability of pulmonary hypertension was low, with an estimated pulmonary artery systolic pressure of 13 mmHg.

The patient was planned to undergo a coronary artery bypass grafting (CABG) surgery. The anesthesia team planned to use total intravenous anesthesia (TIVA). The patient will be taken to the operating room and monitored for BIS, NIRS, oxygen saturation and ECG for comprehensive monitoring. An intravenous line will be established and premedication was given with 5 mg of intravenous midazolam. An arterial line will then be placed for continuous blood pressure monitoring.

The induction will be performed with a combination of sufentanil 25 mcg, propofol 50 mg and rocuronium 50 mg. The depth of anesthesia will be monitored using BIS with a target value between 25-40. After induction, the patient will be intubated with an endotracheal tube (ETT) and connected to a ventilator in VC mode with a tidal volume setting of 450 ml, respiratory rate 12x/mins, PEEP 5 cmH2O, and FiO2 60%. Maintenance will be performed with a continuous infusion of propofol 200 mg/hour, rocuronium 6 mg/hour and sufentanil 12 mcg/hour using a syringe pump.

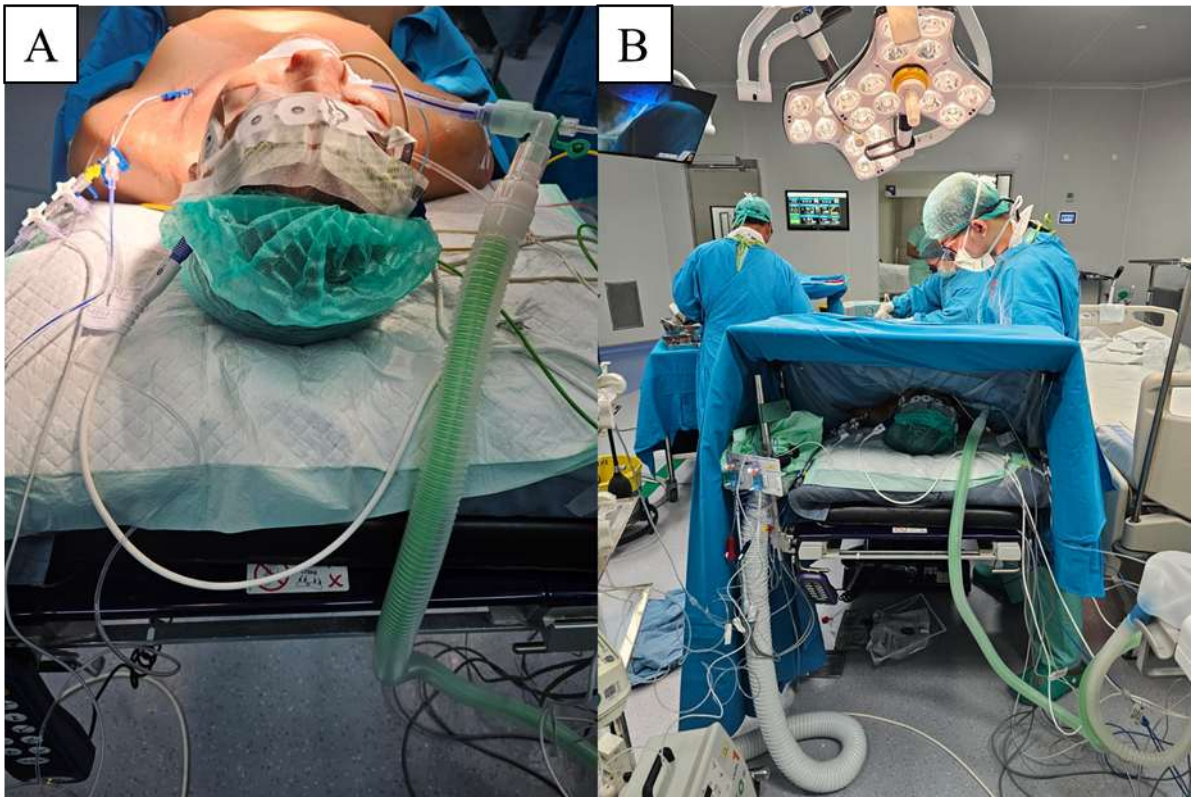

Figure 1. Intraoperative view during CABG surgery.

Dobutamine was administered at a dose of 3-5 mcg/kg/min and nitroglycerin at a dose of 0.5 mcg/kg/min to support hemodynamics during the procedure. After induction of anesthesia and intubation, a 7-F central venous catheter (CVC) in the right subclavian vein and an 8.5-F side port in the right internal jugular vein for additional vascular access and hemodynamic monitoring. Postoperatively, the patient will receive treatment in the ICU on a ventilator in VC mode, with a tidal volume of 450 ml, a respiratory rate of 12x/min, a PEEP of 5 cmH2O and a FiO2 of 60%.

Analgesics will be administered as a morphine infusion of 20 mcg/kg/hour. Extubation will be performed eight hours postoperatively, extubation will be performed eight hours postoperatively, depending upon stable hemodynamics and adequate laboratory results. The medical team will continue to closely monitor the patient's condition and adjust the treatment plan based on the patient's clinical improvement.

The treatment outcome demonstrated that the CABG surgery was performed smoothly. Throughout the procedure, the patient's hemodynamics remained steady with the administration of dobutamine and nitroglycerin. The patient was admitted to the ICU with a ventilator as scheduled postoperatively. Eight hours postoperatively, the patient was successfully extubated with stable hemodynamics (Figure 2). Postoperative laboratory tests indicated slight increases in cardiac enzymes (CK and CK-MB), which were within acceptable parameters for the CABG surgery. The postoperative hemoglobin level decreased to 10 gr/dL, although remained within acceptable limits. The patient's renal function demonstrated a slight decline, with creatinine levels rising to 1.28 mg/dL, although within appropriate parameters for the early postoperative phase following cardiac surgery. The actual outcome aligned with our expectations, signifying a successful procedure and effective perioperative treatment.

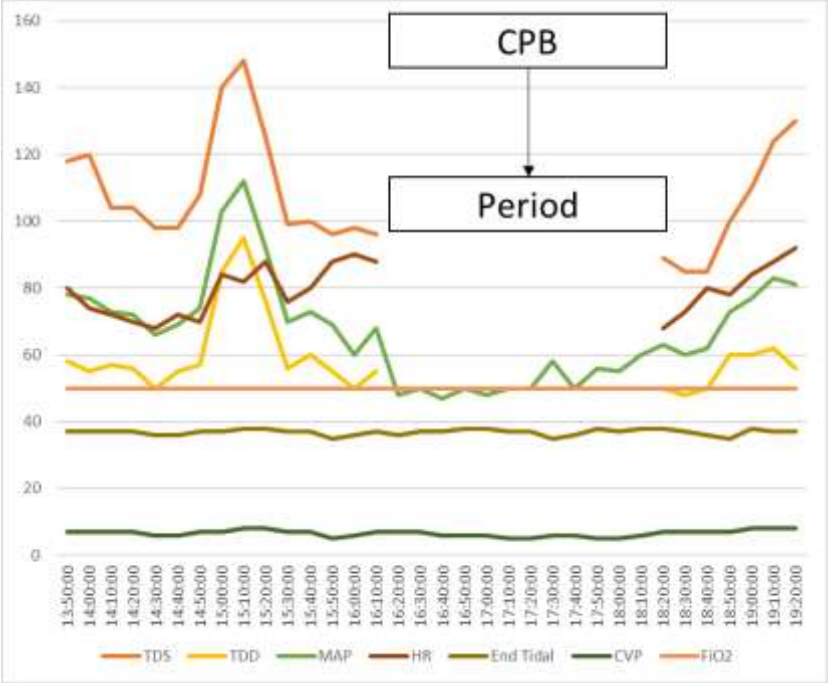

Figure 2. Hemodynamic parameters during the CABG procedure

This case illustrates the management of total intravenous anesthesia (TIVA) in a 66 year-old male patient with three-vessel coronary artery disease (CAD 3VD) undergoing coronary artery bypasss grafting (CABG). The election of TIVA in this case has several considerations and advantages.

First, TIVA may provide better hemodynamic stability than inhalational anesthesia in patients with impaired cardiac function. A study by Basagan-Mogol et al. (2010) showed that a combination of ketamine, midazolam and fentanyl for anesthetic induction provided better hemodynamic stability throughout induction and the end of sternotomy in patients undergoing CABG compared with propofol.(Basagan-Mogol et al., 2010) In this case, induction was performed with a combination of sufentanil, propofol and rocuronium, resulting in effective hemodynamic stability.

Second, the use of TIVA allows for easier titration and faster recovery compared to inhalational anesthetics. This is particularly crucial for patients with impaired cardiac function who require close monitoring and rapid adjustment of anesthetic dosages. Mittnacht et al. (2015) discovered that the administration of short-acting drugs by infusion like propofol and remifentanil facilitates more precise titration and rapid recovery.(Mittnacht et al., 2018) In this case, anesthesia was maintained with a continuous infusion of propofol and sufentanil, allowing titration as required.

Third, TIVA may avoid the potential cardiovascular side effects of volatile anesthesia. A;though some studies have demonstrated the cardioprotective effects of volatile anesthesia, a recent meta-analysis by Xiao et al. (2019) showed no significant difference in mortality and postoperative complications between TIVA and volatile anesthesia in patients undergoing CABG.(Jiao et al., 2019) Therefore, the selection of TIVA in this case can be considered both safe and effective.

Comprehensive hemodynamic monitoring is essential for effective anesthetic treatment in this case. The utilization of BIS, NIRS, oxygen saturation, ECG, arterial line and central venous catheter monitors facilitates careful monitoring of anesthesia depth, brain perfusion, oxygenation, cardiac function and volume status. This corresponds with the suggestions of

Mittnacht et al. (2015) regarding the significance of multimodal monitoring in patients having CABG.(Mittnacht et al., 2018)

Perioperative hemodynamic management was also a primary focus in this case. The use of dobutamine and nitroglycerin to support cardiac function and optimize coronary blood flow aligns with the principles of hemodynamic management in CABG. Mittnacht et al. (2015) emphasized the importance of maintaining myocardial contractility and preventing ischemia during CABG.(Mittnacht et al., 2018)

The selection of rocuronium as a muscle relaxant in this case was suitable due to its moderate duration of action and possibility for rapid recovery relative to other drugs such as pancuronium. This was essential to establish early extubation in accordance with the fast-track methodology applied in this case.

The fast-track protocol with a target extubation 8 hours postoperatively applied in this case aligns with current trends in post-CABG management. Mittnacht et al. (2015) stated that fast-track management with early extubation (4-8 hours postoperatively) has become the standard of care in almost all cardiac centers.(Gropper et al., 2020; Mittnacht et al., 2018) This may speed up patient recovery and reduce the duration of stay in the ICU.(Mittnacht et al., 2018).

CONCLUSION

This case report demonstrated that the TIVA approach in a patient with three-vessel CAD undergoing CABG resulted in favorable clinical outcomes. Meticulous hemodynamic management using dobutamine and nitroglycerin, comprehensive multimodal monitoring with BIS, NIRS, arterial line monitoring, and central venous catheter (CVC) monitoring, along with the implementation of a fast-track protocol, contributed to intraoperative hemodynamic stability and rapid postoperative recovery, with successful extubation 8 hours after surgery. The combination of sufentanil, propofol, and rocuronium was effective and safe as components of TIVA for anesthesia induction and maintenance in this CABG case. No significant anesthetic adverse events were observed, and the patient's hemodynamic parameters remained within acceptable ranges throughout the procedure. Postoperative laboratory findings, including mild elevations in cardiac enzymes and a transient, reversible decline in renal function, remained within acceptable limits for a CABG procedure.

These findings highlight the importance of an individualized anesthetic strategy and comprehensive perioperative management in achieving favorable outcomes for high-risk CABG patients. The use of TIVA with precisely titratable, short-acting agents combined with fast-track protocols may provide an effective framework for optimizing clinical outcomes in patients undergoing coronary revascularization surgery. Further studies with larger sample sizes and prospective designs are required to confirm the potential benefits of TIVA in CABG, particularly regarding organ-protective effects, ICU length of stay, and long-term recovery outcomes. The development of standardized national guidelines for anesthesia management in CABG procedures in Indonesia may also support consistency and quality improvement across healthcare institutions.

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