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*Case Report*

# Remimazolam-based total intravenous anesthesia for prone cervical spine surgery in a patient with previously undiagnosed dilated cardiomyopathy after aborted anesthetic induction: A case report

*Jooyong Lee[1], Sanghi Park[2]*

**SUMMARY**

Unexpected hemodynamic deterioration during anesthesia induction may show previously undiagnosed cardiac dysfunction. Herein, we report a case of successful remimazolam-based total intravenous anesthesia in a patient with newly diagnosed dilated cardiomyopathy (DCMP) who underwent prone cervical spine surgery. A 113-kg man with quadriplegia owing to cervical spinal cord injury underwent emergency cervical decompression and fusion surgery. Severe desaturation and hypotension developed despite $FiO_2$ 1.0 during the initial anesthetic attempt using etomidate and sevoflurane-remifentanil anesthesia, and surgery was aborted. A subsequent evaluation showed DCMP with severely reduced left ventricular systolic function, with a calculated biplane ejection fraction of approximately 37% and a left ventricular ejection fraction of approximately 31% in the apical two-chamber view. Reoperation was performed under total intravenous anesthesia with remimazolam–remifentanil. Although transient desaturation and reduced tidal volume developed after prone positioning, surgery was completed with relatively stable hemodynamics. In conclusion, remimazolam-based total intravenous anesthesia may be useful in selected high-risk patients with severe left ventricular dysfunction.

**KEYWORDS:** Cervical spinal cord injury, Dilated cardiomyopathy, Hemodynamic instability, Prone position, Remimazolam, Total intravenous anesthesia.

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## INTRODUCTION

Dilated cardiomyopathy (DCMP) is characterized by ventricular dilation and impaired left ventricular systolic function and is linked to reduced cardiac reserve and increased perioperative cardiovascular risk.[1] In patients with severe ventricular dysfunction, anesthetic induction and positive-pressure ventilation may further reduce cardiac output and worsen oxygenation, potentially leading to circulatory collapse.[2]

Patients with cervical spinal cord injury may have impaired diaphragmatic function, reduced chest wall compliance, and prolonged ventilator dependence. Obesity and prone positioning may further aggravate respiratory and cardiopulmonary interactions.[3,4]

Remimazolam is a recently introduced ultra-short-acting benzodiazepine characterized by rapid esterase metabolism and relatively stable hemodynamic properties compared with conventional intravenous anesthetics.[5,6] However, reports describing

remimazolam-based anesthesia in patients with severe cardiac dysfunction undergoing prone cervical spine surgery are limited.

Herein, we report a case of successful remimazolam-based total intravenous anesthesia in a patient with previously undiagnosed DCMP, who experienced severe cardiopulmonary deterioration during a previous anesthetic attempt.

## CASE PRESENTATION

A 185-cm, 113-kg man (body mass index, 33 kg/m²) was transferred to our institution with quadriplegia following a fall while intoxicated. Imaging showed cervical spinal cord compression. Therefore, urgent posterior cervical decompression and C3–5 fusion surgery were planned. Neurological examination demonstrated relatively preserved lower-extremity motor function (grade 4/4) but severe upper extremity weakness: shoulder abduction, grade 1/1; elbow flexion and extension, grade 0/0; wrist flexion and extension, grade 1/1; and handgrip strength, grade 1/1. The patient denied a history of cardiovascular disease. However, electrocardiography conducted in the emergency department showed newly detected atrial fibrillation with a ventricular response rate of approximately 79–90 beats/min. Emergency surgery was scheduled without further cardiac evaluation because of progressive neurological deterioration caused by cervical cord compression.

During the initial attempt, anesthesia was induced with etomidate and maintained with sevoflurane and remifentanil. Tracheal intubation was performed without difficulty. Despite apparently adequate ventilation with tidal volumes of approximately 700–800 ml under $FiO_2$ 1.0, oxygen saturation progressively reduced to approximately 90%, accompanied by cyanosis. Simultaneously, the heart rate increased to approximately 120 beats/min, and systolic blood pressure decreased to 80–90 mmHg despite vasopressor administration. Portable chest radiography performed in the operating room revealed cardiomegaly with increased pulmonary vascular/interstitial markings suggestive of underlying cardiac dysfunction (Fig.1). Surgery was aborted because severe hypoxemia and hemodynamic instability persisted despite supportive management, and the patient was transferred to the intensive care unit for further cardiac evaluation.

Subsequent coronary angiography showed approximately 40% stenosis in the mid-left anterior descending artery, without substantial stenosis in the left circumflex or right coronary arteries.

The left ventricular end-diastolic pressure increased to 38 mmHg. Bedside transthoracic echocardiography revealed substantial left ventricular dilation and reduced systolic function. The calculated biplane ejection fraction was approximately 37%, and the left ventricular ejection fraction was approximately 31% in the apical two-chamber view (Fig.2). These findings were consistent with DCMP. Cardiology consultation considered the patient to be at high perioperative risk and recommended continuing dobutamine infusion during surgery. The patient remained intubated and mechanically ventilated in the intensive care unit using assist-control pressure-

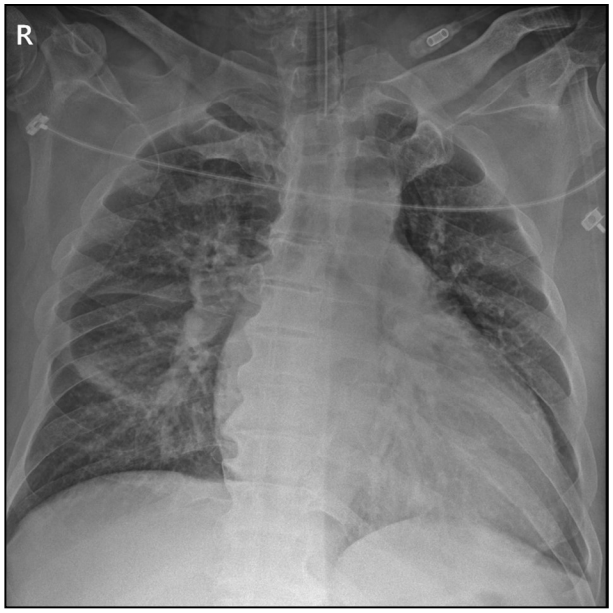


Fig.1: Portable chest radiograph obtained following the aborted initial anesthetic attempt, showing cardiomegaly with prominent pulmonary vascular and interstitial markings, suggestive of underlying cardiac dysfunction.

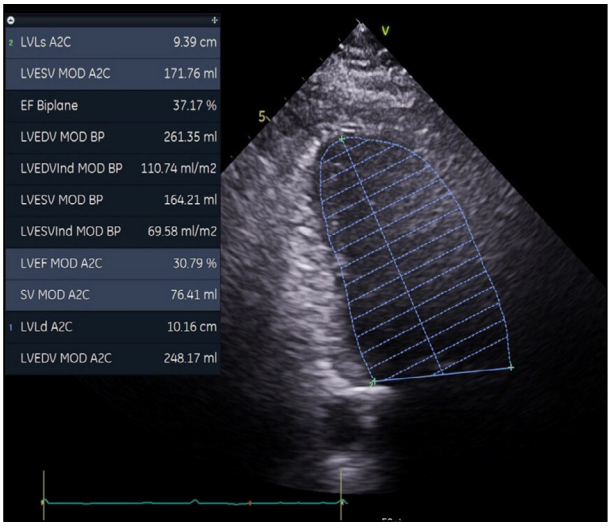


Fig.2: Bedside transthoracic echocardiography showing substantially dilated left ventricular cavity with decreased systolic function. Calculated biplane ejection fraction was approximately 37%, and left ventricular ejection fraction in the apical two-chamber view was approximately 31%. EF, ejection fraction. LV, left ventricle.

controlled ventilation with $FiO_2$ 0.4, respiratory rate 18 breaths/min, pressure control 13 $cmH_2O$, positive end-expiratory pressure (PEEP) 7 $cmH_2O$, and tidal volume approximately 530 ml. Furthermore, dobutamine infusion was maintained at 3 µg/kg/min. Reoperation was planned as neurological deterioration persisted. At the time of reoperation, the patient remained intubated and mildly sedated, with a right peripherally inserted central catheter and a left radial arterial catheter in place. Systolic blood pressure was 130–150 mmHg, and the heart rate was 80–100 beats/min.

General anesthesia was induced with remimazolam combined with remifentanil and maintained with remimazolam-based total intravenous anesthesia. Remimazolam was initiated at 6 mg/kg/h, and remifentanil was continuously infused at 0.5-3 µg/kg/min and titrated according to hemodynamic responses. Remimazolam was titrated to 1–2 mg/kg/h to maintain a bispectral index (BIS) of 40–60. Rocuronium 0.9 mg/kg was administered to provide adequate neuromuscular blockade for surgery. The anesthetic depth was adjusted using continuous remimazolam and remifentanil infusions, and invasive hemodynamic monitoring was maintained throughout surgery.

Mechanical ventilation was conducted using pressure-controlled ventilation with $FiO_2$ 0.5, respiratory rate 18 breaths/min, inspiratory pressure 27 $cmH_2O$, and PEEP 7 $cmH_2O$. Oxygenation remained stable in the supine position. However, after transition to the prone position, oxygen saturation transiently reduced to approximately 93% despite $FiO_2$ 1.0, and tidal volume decreased to approximately 440 ml despite inspiratory pressure of 27 $cmH_2O$. Oxygen saturation gradually recovered to approximately 98% after ventilatory adjustments and continued invasive hemodynamic monitoring, allowing a gradual reduction in $FiO_2$ to 0.8. Intraoperative blood pressure and heart rate remained relatively stable without substantial hypotension or tachyarrhythmia. Dobutamine infusion, initially maintained at 3 µg/kg/min, was gradually tapered to approximately 0.5 µg/kg/min during surgery while maintaining acceptable hemodynamic parameters. The total operative time was approximately two hours 30 minutes, and the total anesthesia time was approximately three hours 20 minutes. The patient was transferred to the intensive care unit while intubated and mechanically ventilated.

***Ethical Approval:*** This case report was approved by the Institutional Review Board of Chungbuk National University Hospital (CBNUH IRB No. 2026-05-027; approval date: May 28, 2026).

## DISCUSSION

This case report describes successful anesthetic management using remimazolam-based total intravenous anesthesia in a patient with previously undiagnosed DCMP, who experienced severe cardiopulmonary deterioration during a previous anesthetic attempt. A notable feature of this case was that the second anesthetic attempt was completed with relatively stable hemodynamics following severe instability during the initial anesthetic induction. Patients with DCMP are especially vulnerable to perioperative hemodynamic deterioration owing to impaired myocardial contractility, increased ventricular volume, and elevated filling pressures.[1,2] Most anesthetic agents cause varying degrees of myocardial depression and vasodilation, which may further decrease cardiac output and precipitate hypotension. Additionally, positive-pressure ventilation and high PEEP may reduce venous return and worsen preload-dependent cardiac dysfunction.[7]

Herein, severe hypoxemia and hypotension developed during the initial anesthetic attempt, despite adequate ventilation and an $FiO_2$ of 1.0. Portable chest radiography revealed cardiomegaly with increased pulmonary vascular/interstitial markings, and subsequent cardiac evaluation showed severe left ventricular systolic dysfunction and elevated left ventricular end-diastolic pressure. Echocardiographic findings revealed substantially dilated left ventricular dimensions with reduced systolic function, supporting the diagnosis of a previously unrecognized DCMP. Thus, occult DCMP may substantially contribute to the cardiopulmonary deterioration observed during anesthetic induction. Ventilatory management was challenging throughout the procedure due to cervical spinal cord injury, obesity, and prone positioning. Patients with cervical spinal cord injury may develop diaphragmatic dysfunction, impaired accessory respiratory muscle activity, and reduced chest wall compliance.[3]

In our patient, high PEEP was necessary even before surgery. Additionally, oxygen desaturation and reduced tidal volume developed following prone positioning, likely due to the reduced chest wall compliance and restricted diaphragmatic excursion linked to obesity and prone positioning.[4] The maintenance of adequate oxygenation while avoiding excessive hemodynamic deterioration was especially important in this patient, as prone positioning may increase intrathoracic pressure and reduce venous return.

Severe hypotension and desaturation had already occurred during the first anesthetic attempt, and minimizing further myocardial depression during the second operation was considered crucial. The initial anesthetic attempt was performed using etomidate induction, followed by sevoflurane-remifentanil anesthesia. Although etomidate is usually considered relatively hemodynamically stable during induction, inhalational anesthetics may still contribute to myocardial depression and vasodilation.

For the second anesthetic attempt, we selected remimazolam-based total intravenous anesthesia combined with remifentanil to facilitate gradual titration of the anesthetic depth while potentially minimizing additional cardiovascular depression. Unlike volatile anesthesia, remimazolam-based total intravenous anesthesia allowed continuous titration of the anesthetic depth while avoiding further inhalational myocardial depressant effects during prolonged prone surgery. In addition, previous studies have suggested that total intravenous anesthesia may be associated with different postoperative analgesic outcomes than inhalational anesthesia, although this was not evaluated in the present case.[8] Remimazolam is an ultra-short-acting benzodiazepine rapidly metabolized by the tissue esterases and is characterized by relatively stable hemodynamic properties compared to conventional intravenous anesthetics.[5,6] Remimazolam may produce less hypotension and lower vasopressor requirements than propofol during general anesthesia.[9] Additionally, recent reports have described successful anesthetic management using remimazolam in patients who have high-risk cardiovascular diseases, including those with heart failure, valvular heart disease, and reduced cardiac function.[10]

In the present case, anesthesia was maintained using a continuous infusion of remimazolam and remifentanil following administration of a half-loading dose of remimazolam. Relatively stable blood pressure and heart rate were maintained throughout the surgery, without significant hypotension or tachyarrhythmia. Additionally, dobutamine infusion could be gradually reduced from 3 μg/kg/min to approximately 0.5 μg/kg/min during surgery. However, these findings should not be interpreted as evidence of the superiority of remimazolam alone. Several factors, including continuous dobutamine support, invasive hemodynamic monitoring, ventilatory adjustments, and careful anesthetic titration, likely contributed to the favorable intraoperative course. Nevertheless, this case suggests that remimazolam-based total intravenous anesthesia may facilitate anesthetic maintenance without additional major hemodynamic deterioration even in patients with severe left ventricular dysfunction.

In conclusion, previously undiagnosed DCMP may initially present with severe hypoxemia and hemodynamic instability during induction of anesthesia. Remimazolam-based total intravenous anesthesia may be considered an alternative anesthetic strategy in patients with severe cardiac dysfunction who are at high risk of hemodynamic instability, especially when avoidance of additional myocardial depression is desirable.

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## REFERENCES

1. Weintraub RG, Semsarian C, Macdonald P. Dilated cardiomyopathy. Lancet. 2017;390(10092):400-414. doi: 10.1016/S0140-6736(16)31713-5
2. Heidenreich PA, Bozkurt B, Aguilar D, Allen LA, Byun JJ, Colvin MM, et al. 2022 AHA/ACC/HFSA guideline for the management of heart failure: A report of the American College of Cardiology/American Heart Association joint committee on clinical practice guidelines. Circulation. 2022;145(18):e895-e1032. doi: 10.1161/CIR.0000000000001063
3. Berlly M, Shem K. Respiratory management during the first five days after spinal cord injury. J Spinal Cord Med. 2007;30(4):309-318. doi: 10.1080/10790268.2007.11753946
4. Kwee MM, Ho YH, Rozen WM. The prone position during surgery and its complications: a systematic review and evidence-based guidelines. Int Surg. 2015;100(2):292-303. doi: 10.9738/INTSURG-D-13-00256.1
5. Kilpatrick GJ, McIntyre MS, Cox RF, Stafford JA, Pacofsky GJ, Lovell GG, et al. CNS 7056: a novel ultra-short-acting benzodiazepine. Anesthesiology. 2007;107(1):60-66. doi: 10.1097/01.anes.0000267503.85085.c0
6. Sneyd JR, Gambus PL, Rigby-Jones AE. Current status of perioperative hypnotics, role of benzodiazepines, and the case for remimazolam: a narrative review. Br J Anaesth. 2021;127(1):41-55. doi: 10.1016/j.bja.2021.03.028
7. Magder S, Guerard B. Heart-lung interactions and pulmonary buffering: lessons from a computational modeling study. Respir Physiol Neurobiol. 2012;182(2-3):60-70. doi: 10.1016/j.resp.2012.05.011
8. Lee JY, Jeong ST, Hwang JH, Park SH. Postoperative analgesia in patients undergoing thoracotomy: A comparison between total intravenous anesthesia and inhalation anesthesia. Pak J Med Sci. 2024;40(10):2219-2222. doi: 10.12669/pjms.40.10.9907
9. Doi M, Morita K, Takeda J, Sakamoto A, Yamakage M, Suzuki T. Efficacy and safety of remimazolam versus propofol for general anesthesia: a multicenter, single-blind, randomized, parallel-group, phase IIb/III trial. J Anesth. 2020;34(4):543-553. doi: 10.1007/s00540-020-02788-6
10. Kitaura A, Sakamoto H, Hamasaki S, Tsukimoto S, Nakajima Y. Remimazolam-based anesthesia in patients with heart failure due to mitral regurgitation and low left ventricular function: a case series. Medicina (Kaunas). 2023;59(12):2136. doi: 10.3390/medicina59122136

***Authors' Contribution:***

**JL and SP:** Conceived and prepared the report.
**JL:** Collected the clinical data and drafted the manuscript.
**SP:** Supervised the study and critically revised the manuscript.
**JL and SP:** Approved the final manuscript and are responsible for the accuracy and integrity of the study.