Research

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Patient State Index Monitoring for Postoperative Sedation After Liver Transplantation

Catherine Mitchell
Department of Intensive Care Unit, France

***Corresponding Author:**
Catherine Mitchell
Department of Intensive Care Unit, France

Received Date: 08 Dec 2025
Accepted Date: 27 Dec 2025
Published Date: 06 Jan 2026

Citation: Catherine Mitchell, Patient State Index Monitoring for Postoperative Sedation After Liver Transplantation AMCC; 2025; 1: 1-3

1. Abstract

1.1. Background: Accurate monitoring of sedation depth and appropriate drug selection are essential to reduce the risks of oversedation and drug-related adverse effects. This study evaluated the safety and efficacy of Patient State Index (PSI) monitoring compared with the Ramsay Sedation Scale (RSS) for postoperative sedation in living donor liver transplantation (LDLT) recipients.

1.2. Methods: Sixty mechanically ventilated LDLT recipients sedated with desflurane were randomly assigned to either RSS-guided sedation (R group, n = 30) or PSI-guided sedation using SEDLine monitoring (S group, n = 30), targeting PSI values of 50–75. Cognitive recovery was assessed using five-word recall, Trieger's dot test (TT), and digit symbol substitution test (DSST). Hemodynamic parameters were monitored using transesophageal Doppler. Duration of mechanical ventilation, postoperative adverse effects, and sedation-related costs were recorded.

1.3. Results: Time from cessation of desflurane to eye opening, hand squeezing, response to verbal commands, and tracheal extubation was significantly shorter in the S group compared with the R group ($p < 0.001$). Cognitive recovery scores were significantly better in the S group. Fewer patients required norepinephrine support in the S group compared with the R group (33.3% vs. 76.7%, $p = 0.001$). Duration of mechanical ventilation was significantly shorter in the S group. Systemic vascular resistance and mean blood pressure were better preserved in the S group throughout the sedation period. Postoperative drowsiness, nausea, and vomiting were significantly less frequent in the S group. Sedation-related costs were lower in the S group.

1.4. Conclusion: PSI-guided sedation improved hemodynamic stability, enhanced recovery, facilitated faster weaning from mechanical ventilation, and reduced costs compared with RSS-guided sedation, without increasing adverse effects.

2. Keywords: Living donor liver transplantation; Patient State Index; SEDLine; Sedation; Recovery

3. Introduction

Postoperative intensive care management following liver transplantation focuses on hemodynamic stabilization, early weaning from mechanical ventilation, correction of coagulopathy, preservation of renal function, prevention of graft rejection, and infection control. Many liver transplant recipients require postoperative mechanical ventilation and continuous sedation, making the balance between adequate sedation and avoidance of oversedation particularly challenging.

Excessive sedation may prolong mechanical ventilation and increase morbidity and mortality. Continuous brain function monitoring has been introduced to provide objective assessment of sedation depth and reduce sedation-related complications. The Patient State Index (PSI), derived from processed electroencephalography, has demonstrated reliability in overcoming electromyographic interference and accurately reflecting sedation depth. This study evaluated the clinical value of PSI monitoring compared with conventional Ramsay Sedation Scale assessment in postoperative LDLT recipients sedated with desflurane in the ICU.

4. Patients and Methods

This prospective, randomized, double-blinded controlled study was conducted after institutional ethical approval and written informed consent. Sixty adult patients undergoing LDLT with MELD scores between 12 and 20 were enrolled. Patients with severe postoperative hemodynamic instability, neurological disorders, need for reoperation, or inability to cooperate were excluded.

Following surgery, all patients were sedated with desflurane and mechanically ventilated in the ICU. Patients were randomly assigned to RSS-guided sedation targeting a Ramsay score of 4 or PSI-guided sedation targeting PSI values between 50 and 75. ICU physicians were blinded to group allocation and titrated desflurane concentrations accordingly. Fentanyl was administered as needed for analgesia.

Hemodynamic parameters, including heart rate, mean blood pressure, systemic vascular resistance, and cardiac output, were

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continuously monitored using transesophageal Doppler. Emergence times, extubation time, duration of mechanical ventilation, sedative and analgesic consumption, norepinephrine requirements, postoperative adverse effects, and sedation-related costs were recorded.

Cognitive recovery was assessed preoperatively and at 60 and 120 minutes after extubation using five-word recall, Trieger's dot test, and digit symbol substitution test.

5. Results

Baseline demographic characteristics, MELD scores, and intraoperative variables were comparable between both groups. There were no significant differences in operative duration, blood loss, opioid consumption, or transfusion requirements.

During ICU sedation, heart rate remained comparable between groups. Mean blood pressure and systemic vascular resistance were significantly better preserved in the PSI-guided group throughout the sedation period. Cardiac output did not differ significantly between groups. The proportion of patients requiring norepinephrine support was significantly lower in the PSI-guided group.

Emergence from sedation was significantly faster in the PSI-guided group, with shorter times to eye opening, response to verbal commands, and tracheal extubation. Total desflurane consumption and end-tidal concentrations were significantly lower in the PSI-guided group. Duration of mechanical ventilation was also significantly reduced.

Postoperative cognitive recovery was superior in the PSI-guided group, as demonstrated by better performance in five-word recall, Trieger's dot test, and digit symbol substitution test. Postoperative drowsiness, nausea, and vomiting occurred less frequently in the PSI-guided group. Sedation-related costs were significantly lower in the PSI-guided group.

6. Discussion

PSI-guided sedation allowed continuous, objective assessment of sedation depth without repeated patient stimulation, reducing the incidence of oversedation. This resulted in lower sedative requirements, improved hemodynamic stability, faster emergence, and enhanced cognitive recovery.

Desflurane proved effective for ICU sedation in liver transplant recipients due to its rapid elimination and favorable hemodynamic profile. Preservation of systemic vascular resistance is particularly beneficial in cirrhotic patients, as it improves central blood volume and organ perfusion.

The reduced duration of mechanical ventilation observed with PSI-guided sedation aligns with previous evidence that minimizing sedative exposure improves ICU outcomes. Additionally, reduced postoperative complications and lower costs further support the use of PSI monitoring in this patient population.

7. Conclusion

PSI-guided sedation in mechanically ventilated living donor liver transplant recipients provides superior hemodynamic stability, faster recovery, shorter duration of mechanical ventilation, fewer postoperative complications, and lower costs compared with Ramsay Sedation Scale–guided sedation. PSI monitoring enables significant reduction in sedative dose while maintaining adequate sedation without adverse effects.

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