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# Rescue and Nursing Strategies for a Case of Cardiac Arrest Induced by Vagal Reflex After Lumbar Spine Surgery Under the ERAS Concept

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**Abstract:** This paper summarizes the nursing experience in rescuing a patient who developed a severe circulatory collapse due to an exaggerated vagal reflex following posterior lumbar decompression, bone graft fusion, and internal fixation surgery. In response to this rapidly onset complication, the nursing team implemented proactive interventions: early warning monitoring based on multidimensional risk assessment and blocking pain management targeting key links in the "Baroreceptor-Vagal Reflex Arc". When the patient experienced sudden cardiac arrest, seamless integration with the ICU and advanced life support were ensured within the "golden 2 minutes" of cardiopulmonary resuscitation (CPR). After stabilization, the Enhanced Recovery After Surgery (ERAS) protocol was individually adjusted based on evidence. Through systematic rescue and nursing, the patient achieved stable circulation without neurological sequelae and recovered successfully.

**Keywords:** Post-lumbar surgery; Circulatory collapse; Vagal reflex; Enhanced recovery after surgery; Perioperative nursing

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## 1. Introduction

The Enhanced Recovery After Surgery (ERAS) concept, through a series of evidence-based optimization measures, effectively reduces surgical stress, minimizes complications, and promotes recovery. Its application in lumbar fusion surgery has been shown to shorten hospital stays and improve patient satisfaction [1,2]. Circulatory instability after lumbar surgery is often attributed to common causes such as bleeding, pulmonary embolism, or acute coronary syndrome, while severe circulatory collapse mediated by an exaggerated vasovagal reaction (VVR) is frequently overlooked. This type of reaction has a rapid onset and progression, and if not promptly identified and managed, can quickly lead to cardiac arrest, posing a significant threat to patient safety [3]. Currently, there is a lack of mature consensus on systematic nursing intervention protocols for VVR after lumbar surgery, particularly on how to effectively integrate and balance risks with the ERAS

protocol. Therefore, this paper summarizes the successful rescue and nursing experience of a patient who developed severe circulatory collapse due to VVR after posterior lumbar decompression, bone graft fusion, and internal fixation surgery, aiming to provide a reference for clinical identification and management of this rare but critical complication.

## 2. Clinical data

### 2.1. General information

The patient was a 66-year-old male farmer admitted with "low back and bilateral buttock pain with limited mobility for more than one week". He was 172 cm tall, weighed 68 kg, and had a body mass index (BMI) of 23.0 kg/m$^2$. He denied a history of smoking, alcohol use, or drug allergies. Past medical history included renal calculi and surgical history for right clavicle and right ear trauma; he denied a history of hypertension or diabetes (blood pressure upon admission was 141/91 mmHg, requiring attention). Preoperatively (April 26–28, 2024), he experienced severe pain in the lumbosacral region and left buttock, with a Visual Analog Scale (VAS) score of 6–7, accompanied by limited left ankle dorsiflexion. Lumbar MRI revealed: Grade I spondylolisthesis of the L4 vertebra, L4/5 disc herniation with spinal stenosis, and decreased bone density.

### 2.2. Treatment and outcome

The patient underwent posterior lumbar decompression, bone graft fusion, and internal fixation under general anesthesia on April 29, 2024. The surgery was successful and lasted 3 hours. He returned to the ward at 16:30 on the same day. Approximately 40 minutes postoperatively (17:10), the patient suddenly lost consciousness. Cardiac monitoring showed a sudden drop-in heart rate to 28 beats per minute, blood pressure to 75/40 mmHg, and pulse oxygen saturation ($SpO_2$) to 50% despite oxygen inhalation. Physical examination revealed weak arterial pulses, dilated pupils, and sluggish light reflexes, leading to a diagnosis of cardiac arrest. Immediate continuous chest compressions and manual bag-valve-mask ventilation were initiated, and the ICU green channel was activated for emergency transfer. The patient was transferred to the ICU at 17:12 and underwent emergency tracheal intubation. Spontaneous heartbeat and blood pressure resumed after approximately 2 minutes, and $SpO_2$ increased to 100%. Subsequent laboratory tests showed transient elevations in D-dimer (4.03 mg/L) and troponin I (4.457 ng/mL), but acute pulmonary embolism and myocardial infarction were ruled out by imaging studies. Based on clinical presentation, the final diagnosis was severe circulatory collapse caused by an exaggerated vasovagal reaction (VVR) [4–6]. Under close ICU monitoring, the patient's vital signs stabilized without neurological sequelae, and he was transferred back to the general ward on postoperative day 5 for continued rehabilitation.

## 3. Nursing

### 3.1. Implementation of early warning monitoring based on risk assessment

The patient was classified as a level I nursing care object, and an upgraded monitoring protocol was implemented. First, continuous vital sign monitoring was initiated: upon returning to the ward, the patient's electrocardiogram, blood pressure, heart rate, and $SpO_2$ were continuously monitored, with the frequency increased to every 15 minutes. After stabilization, the frequency was reduced to every 30 minutes. Second, trend alarm thresholds were set: in addition to conventional high/low-value alarms, special linked trend

alarms were established. If the heart rate and mean arterial pressure (MAP) simultaneously decreased by more than 20% of the baseline value within 5 minutes, a highest-priority alarm was triggered to identify early signs of circulatory deterioration. Finally, emergency equipment was kept bedside: a "rapid response pack" containing atropine, ephedrine injections, syringes, and a simple respirator was prepared at the bedside to ensure immediate access to rescue items.

## 3.2. Multimodal pain management aimed at blocking the reflex arc

To prevent severe pain from triggering a vagal reflex, a proactive multimodal pain management strategy was adopted. For pharmacological pain control: a patient-controlled intravenous analgesia (PCIA) pump was used as prescribed, with a formulation of 100 μg of sufentanil combined with 3 mg of granisetron, diluted to 100 mL, and a background infusion rate of 2 mL/h. Additionally, starting on postoperative day 1, 50 mg of flurbiprofen axetil injection was administered intravenously every 12 hours as basal analgesia. Pain assessment: the Visual Analog Scale (VAS) was used to assess pain every 2 hours; when the patient complained of pain or had a VAS score ≥ 4, he was instructed to use the PCIA for additional doses, and the effect was evaluated promptly. For non-pharmacological interventions: before procedures such as turning or dressing changes, the patient was fully informed, and actions were performed gently; he was also guided to perform abdominal deep breathing exercises and listen to music to distract attention and increase pain tolerance thresholds.

## 3.3. Execution of the "golden 2 minutes" in-hospital emergency response protocol

When the patient experienced cardiac arrest, the nursing team immediately activated the emergency plan:

(1) Immediate high-quality CPR

The first nurse confirmed loss of consciousness and absence of arterial pulses at 17:10 and immediately began chest compressions (rate: 100–120 compressions per minute, depth: 5–6 cm).

(2) Parallel team collaboration

The second nurse simultaneously called for support, notified the physician, and used a simple respirator to provide assisted ventilation at a compression-to-ventilation ratio of 30:2; the third nurse activated the rapid response team (RRT) and used the SBAR communication model to alert the ICU: "Orthopedics, Bed XX, post-lumbar surgery patient, sudden loss of consciousness, heart rate 28 beats per minute, unmeasurable blood pressure, currently undergoing CPR, request immediate admission and preparation for intubation".

(3) Seamless transfer under continuous life support

While preparing the transfer bed, CPR and artificial ventilation were continued, and the patient was safely transferred to the ICU at 17:12 without interruption of basic life support en route.

## 3.4. Individualized rehabilitation process adjustment based on hemodynamic stability

Given the patient's severe circulatory collapse, the standard ERAS early mobilization protocol was individually adjusted after discussion with the medical team. Early postoperative period (24–48 hours): ambulation was temporarily suspended, and focus was placed on bed exercises, including one set of ankle pump exercises (10 repetitions per set) and quadriceps isometric contractions (holding for 5–10 seconds per repetition, 10 repetitions per set) every hour. Additionally, an intermittent pneumatic compression (IPC) device was used twice daily to prevent deep vein thrombosis. Mid-postoperative period (from day 3 onwards): after transfer to the general ward, stabilization of vital signs, and discontinuation of vasoactive

drugs for 24 hours, the patient attempted to stand beside the bed under close nursing supervision for the first time. If no dizziness, palpitations, or unstable blood pressure or heart rate occurred, he gradually transitioned to short-distance indoor walking.

## 4. Discussion

This case reports a case of post-lumbar surgery circulatory collapse induced by severe vasovagal reflex (VVR) under ERAS management.

### 4.1. Pathophysiological mechanisms of vasovagal reflex (VVR) and risk reassessment in the ERAS context

Enhanced Recovery After Surgery (ERAS), through its core strategies such as multimodal analgesia and encouragement of early mobilization, has demonstrated significant improvements in patient outcomes. However, these measures may also increase the risk of VVR under specific conditions. The pathophysiological core of VVR lies in the excessive activation of the Bezold-Jarisch reflex (BJR). BJR is a cardiopulmonary chemoreceptor reflex: when mechanoreceptors or chemoreceptors in the left ventricular inferoposterior wall are stimulated by factors such as relative hypovolemia, severe pain, or emotional stress, signals are transmitted via vagal afferent fibers (C fibers) to the nucleus tractus solitarius in the medulla oblongata, leading to enhanced vagal efferent activity and inhibition of sympathetic activity, ultimately resulting in the classic "triad" of bradycardia, vasodilation, and hypotension [4–6].

This patient exhibited multiple high-risk factors for triggering BJR:

(1) High-intensity pain stimulation

A preoperative VAS score of 6–7 indicated a state of hyperalgesia, and postoperative acute pain served as a strong abnormal afferent stimulus.

(2) Potential autonomic nervous system dysregulation

The patient's blood pressure upon admission (141/91 mmHg) was at the upper limit of normal, suggesting that his vascular tone regulation and stress buffering capacity might already be at a critical level.

(3) Surgical stress and circulatory volume changes

The 3-hour posterior surgery constituted significant physiological stress, and postoperative fluid redistribution may have led to relative hypovolemia, collectively reducing left ventricular preload and increasing the sensitivity of cardiac mechanoreceptors.

### 4.2. Reconstruction of nursing strategies: From passive monitoring to mechanism-based proactive intervention

The core transformation in nursing practice in this case lies in the implementation of measures based on the pathophysiological mechanisms of VVR, achieving a shift from outcome response to upstream intervention.

First, the "trend alarm" system enabled intelligent upgrading of risk warning. Unlike conventional monitoring, which focuses solely on absolute value alarms for vital signs, the linked trend alarm set in this case, which targeted the simultaneous decrease in heart rate and MAP by more than 20% within 5 minutes, directly addressed the characteristic hemodynamic changes following BJR activation (i.e., synchronous decreases in heart rate and blood pressure) [7].

Second, the multimodal analgesia strategy aimed to block the initiation of the reflex arc at its source. The nursing goal was not only to control pain scores but also to eliminate strong afferent signals triggering BJR

through preventive analgesia. Specifically, the scheduled administration of flurbiprofen axetil (a nonsteroidal anti-inflammatory drug) reduced peripheral nociceptor sensitization by inhibiting cyclooxygenase and decreasing prostaglandin synthesis, while patient-controlled sufentanil (an opioid) acted on μ-receptors in the central nervous system to elevate the pain threshold [8].

### 4.3. Emergency response and ERAS individualization: The dialectical unity of safety assurance and accelerated rehabilitation

The successful rescue in this case is empirical evidence of the efficient operation of the in-hospital rapid response team (RRT). As the first responder, the nurse's rapid initiation of CPR and precise information transmission using the SBAR model perfectly embodied the core of RRT, "early identification, rapid response", highlighting the critical decision-making role of nurses in critical incidents. This profoundly illustrates that the effective implementation of the ERAS pathway must be grounded in a robust emergency response capability; otherwise, "accelerated recovery" may be compromised by sudden complications. Furthermore, ERAS is not a rigid doctrine but a clinical management framework centered on patient safety that allows and requires dynamic adjustments based on real-time clinical condition [9–12].

### 4.4. Limitations and prospects

This study is a single-case report, and the generalizability of its conclusions requires validation by larger-sample studies. However, the issues it reveals are of significant importance, pointing the way for future clinical practice and research:

(1) Construction of a risk prediction model

Multicenter studies are needed to identify independent risk factors for severe VVR after spinal surgery and develop a simple, practical preoperative risk assessment tool.

(2) Integration of early warning strategies into the ERAS pathway

It is recommended that VVR risk assessment and graded monitoring protocols be formally incorporated into the standardized nursing pathway for ERAS in spinal surgery.

(3) Strengthening nursing training and capacity building

Identification and initial management protocols for rare but critical complications such as VVR should be included in the core competency training and regular simulation drills for orthopedic nurses. Furthermore, the authority and procedures for nurses to initiate emergency responses and perform initial rescues in critical situations should be further clarified.

## 5. Conclusion

The successful treatment of circulatory failure caused by vasovagal reflex (VVR) after lumbar spine surgery in this case demonstrates that, under the Enhanced Recovery After Surgery (ERAS) concept, the nursing role needs to undergo a profound transformation from a plan executor to an active risk manager and a core emergency decision-maker. By implementing a comprehensive nursing strategy that takes risk assessment as the premise, early warning monitoring as the sentinel, pain blockade as the key, and extreme response as the guarantee, it is possible to effectively identify and respond to such concealed and rapidly progressing serious complications. This case suggests that it is necessary to integrate the systematic evaluation and intervention process of VVR into the ERAS guidelines for spinal surgery in the future, and to emphasize the specialized training and clinical authorization of nurses in early identification of warning signs, independent initiation of

advanced life support, etc., thereby constructing a more robust perioperative safety barrier [7].

## Disclosure statement

The authors declare no conflict of interest.

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