Challenge Journal of PERIOPERATIVE MEDICINE

Vol.3 No.1 (2025)

acute pain anesthesiology artificial intelligence decision making erector spinae evaluation evidence-based care fluid management monitoring nerve block pain management perichondral approach perioperative medicine plane blocks postoperative pain reanimation recovery program regional anesthesia remedy risk score simulation models surgery surgical optimization ultrasound tests

ISSN 2980-292X

TULPAR ACADEMIC PUBLISHING

Challenge Journal of Perioperative Medicine

E-mail: *cjpm@challengejournal.com*

Web page: *cjpm.challengejournal.com*

Tulpar Academic Publishing
www.tulparpublishing.com

Challenge Journal of Perioperative Medicine

CONTENTS

Challenge Journal of Perioperative Medicine

Research Article

Retrospective evaluation of analgesia approaches in patients undergoing thoracic surgery over the last one year: A single-center study

Mehmet Akif Yilmaz [a,*], Nuray Uzun [a], Elif Oral Ahiskalioglu [a,*], Ali Bilal Ulas [b]

[a] *Department of Anesthesiology and Reanimation, Atatürk University School of Medicine, Erzurum, Türkiye*
[b] *Department of Thoracic Surgery, Atatürk University School of Medicine, Erzurum, Türkiye*

ABSTRACT

Objective: Providing adequate analgesia after thoracic surgery plays an important role in preventing pulmonary complications while accelerating postoperative recovery. This study aimed to retrospectively evaluate the effectiveness of analgesia approaches applied to patients who underwent thoracic surgery at Atatürk University Research Hospital in the last year. This study aimed to retrospectively evaluate the effectiveness of analgesia approaches applied to patients who underwent thoracic surgery at Atatürk University Research Hospital in the last year by comparing different analgesia methods in terms of rescue analgesia requirements.

Method: This retrospective study was conducted by examining the archive files of patients who underwent thoracic surgery between 2024-2025. Patients were classified according to the analgesia methods applied. The analgesic method used was compared according to the type of surgery applied and the need for rescue analgesia.

Results: Intravenous opioid was determined as the most frequently used analgesia method in the analyzed patient group. Rescue analgesia requirement was observed to be the lowest in patients who underwent epidural analgesia. In patients who underwent paravertebral block, it was observed that effective analgesia was provided and the need for rescue analgesia decreased.

Conclusion: Epidural analgesia and paravertebral block stand out as effective methods in analgesia management after thoracic surgery. However, the specific advantages and complication risks of each method should be considered. Secondary objectives of this study include analyzing the relationship between analgesia selection and surgical type (VATS and thoracotomy) and determining the choice of analgesia method and its rationale. It is thought that the findings of this study will contribute to the determination of optimal analgesia strategies after thoracic surgery.

ARTICLE INFO

Article history:
Received – January 5, 2025
Revision requested – February 11, 2025
Revision received – February 14, 2025
Accepted – February 25, 2025

Keywords:
Thoracic surgery
Postoperative analgesia
Epidural analgesia
Paravertebral block
Pain management

Citation: Yilmaz MA, Uzun N, Oral Ahiskalioglu E, Ulas AB. Retrospective evaluation of analgesia approaches in patients undergoing thoracic surgery over the last one year: A single-center study. *Chall J Perioper Med.* **2025**; 3(1):1–7.

1. Introduction

Thoracic surgery is one of the surgical procedures that cause severe pain in the postoperative period and therefore requires effective analgesia management [1]. Because minimally invasive techniques provide a more comfortable recovery process, methods such as video-assisted thoracoscopic surgery (VATS) are preferred over open thoracotomy for many thoracic surgery procedures [2]. Inadequate pain control may lead to decreased patient comfort, increased pulmonary complications, impaired respiratory functions, and prolonged recovery [3]. Therefore, effective management of pain in the post-thoracic surgery period is of critical importance

* *Corresponding author*. E-mail address: mehmetakifyilmaz025@gmail.com (M. A. Yilmaz)
ISSN: 2980-292X / DOI: https://doi.org/10.20528/cjpm.2025.01.001

not only to increase patient satisfaction but also to prevent complications and improve the treatment process [4]. Multimodal analgesia approaches are widely used in postoperative pain management among patients undergoing thoracic surgery. Methods such as epidural analgesia, plane blocks, and combination of intravenous opioid and non-opioid drugs have been developed [1]. However, the efficacy, safety and effects of these methods on patient outcomes are reported with different results in the literature. Therefore, retrospective evaluations aimed at understanding the success of these methods in clinical applications provide important information on analgesia management [5]. This study aims to retrospectively evaluate analgesia approaches in patients undergoing thoracic surgery. The effectiveness of analgesia methods applied in the last year and their effects on patient outcomes are analyzed, and the aim is to demonstrate the success of current practices and develop recommendations that can guide future clinical approaches.

Systematic analyses of regional anesthesia techniques applied for analgesia after thoracic surgery at Atatürk University Medical Faculty Education and Research Hospital are insufficient. Determining the effectiveness of analgesic methods used according to the type of surgery and the need for rescue analgesia are important in terms of identifying deficiencies in current practices.

This study aims to retrospectively examine the frequency and effectiveness of regional anesthesia techniques in patients undergoing thoracic surgery. It is aimed that the data obtained will guide the arrangements that will increase patient safety and satisfaction, contribute to the development of educational strategies and form the basis for evidence-based practices.

The primary objective of this study was to compare the effectiveness of different postoperative analgesia techniques by evaluating the need for rescue analgesia in patients undergoing thoracic surgery. Secondary objectives included analyzing the relationship between analgesia selection and surgical type (VATS vs. thoracotomy) and determining the distribution and rationale for analgesia method selection.

2. Materials and Methods

The necessary ethics committee approval (B.30.2.ATA.0.01.00/790) was obtained for the conduct of the study. The study included a one-year period (January 1, 2024 - December 31, 2024) of patients undergoing thoracic surgery. The recorded file information of adult patients undergoing elective thoracic surgery was examined. Patients between the ages of 18 and 90 and whose American Society of Anesthesiologists (ASA) physical status was 1-4 were included in the study. The groups excluded from the study were those under the age of 18 - over the age of 90, patients who underwent emergency surgery, and those with missing data. A case follow-up form was prepared in advance for the study. This form includes demographic information (age, gender, height, weight) of the patients, as well as ASA physical status, diagnoses, types of operations performed, types of anesthesia, operation times, intraoperative analgesia methods, selected postoperative analgesia types, rescue analgesia needs, times of rescue analgesia need, and hospital stay. After accessing the archive files, demographic information and diagnoses of the patients were obtained from the anamnesis files. In addition, diseases and ASA scores were obtained from the premedication file. Information on the type of anesthesia, intraoperative opioid use and analgesia management was collected from the anesthesia follow-up form filled during the operation. Postoperative data were obtained from doctors' orders and nurse follow-up forms. Finally, hospital stay was obtained from the epicrisis file.

2.1. Our clinic's patient management in thoracic surgery operations

The primary surgical approach of the thoracic surgery clinic includes VATS. As a routine practice of our clinic, all patients who will undergo elective surgery are evaluated preoperatively by anesthesiologists in the outpatient clinic. General anesthesia was applied to our patients during surgery. All patients receive 1 gr paracetamol and 50 mg dexketoprofen iv (intravenous) intraoperatively. In order for patients to have a comfortable postoperative period, regional analgesia techniques are used, except for contraindications. As a routine practice of our clinic, thoracic epidural analgesia (TEA) is used as an intraoperative and postoperative analgesic method in thoracotomy cases. For intraoperative analgesia, patients were given analgesic fluid at 60-minute intervals. Epidural fluid contains 20 mg bupivacaine and 50 mcg fentanyl and is mixed with physiological saline to make a total of 20 ml. Depending on the patient's hemodynamics, this fluid is administered as 5-7 ml or 10 ml. Various regional analgesia techniques are used in VATS. The most common regional analgesia techniques used in our clinic routinely are thoracic paravertebral block (TPVB), erector spinae plane block (ESPB), and serratus anterior plane block (SAPB), although other plane blocks (e.g., external oblique intercostal (EOI) plane block, pectoserrattus plane block, interpectoral plane block) are also used rarely. As a routine practice in our clinic, all regional analgesia techniques are performed under general anesthesia and at the end of the operation, approximately 30 minutes before extubation. These techniques are performed at levels determined by the scope of the surgery and the needs of the patient. As a routine practice of our clinic, our approach to postoperative analgesia management is: If an epidural is placed in patients, a bolus of 10 ml fluid is administered every 12 hours for postoperative pain control. The fluid content includes 2 mg morphine and 30 mcg fentanyl. As a routine practice in our clinic, PCA is applied to patients who cannot receive regional analgesia technique for any reason. In PCA, the basal infusion is set to 20 mcg fentanyl per hour and the patient bolus is set to 20 mcg fentanyl. As a routine practice of our clinic, the toxic dose of the local anesthetic to be administered is calculated to avoid local anesthesia systemic toxicity (LAST) in patients who will undergo local anesthesia. Analgesic plane block is performed with 40 ml of 0.25% bupivacaine, provided that the calculated toxic dose is not exceeded. For multimodal

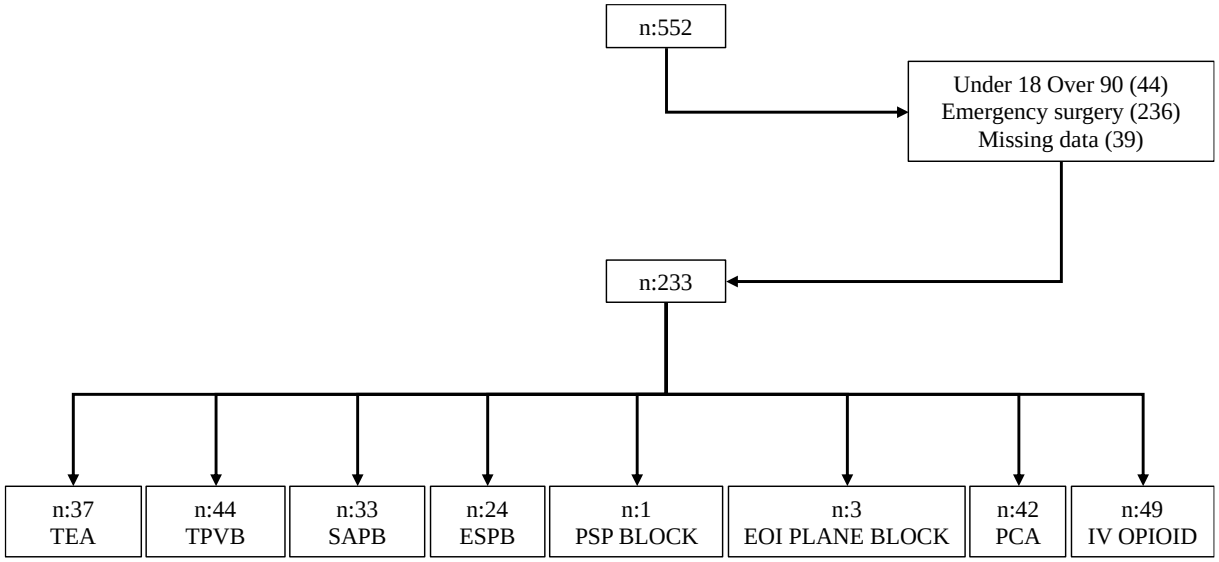
analgesia in the postoperative period, 1 g of paracetamol every 6 hours and 50 mg of dexketoprofen every 8 hours are administered intravenously to patients, and 50 mg of intravenous tramadol is administered as rescue analgesia to patients with a visual analog scale (VAS) value of 4 and above.

In our clinic, the management of postoperative analgesia in patients who have undergone thoracic surgery and who do not receive regional analgesia or PCA is left to the surgical team. These patients are ordered to receive 100 mg tramadol intravenously twice a day during the postoperative period. In our study, this patient group is defined as the group receiving IV opioid treatment.

3. Results

A total of 552 patients underwent thoracic surgery at our center during the specified date range. 319 patients who underwent emergency thoracic surgery under the age of 18 or over the age of 90 and whose data were incomplete for the study were not included in the study. A total of 233 patients' data were included in the review for our study (Figs. 1–4).

Of the patients, 50.6% were female, 49.4% were male, and their mean age was determined as 48.96 ± 17.85 years. The mean body weight was 73.27 ± 15.90 kg, and the height was 167.24 ± 10.92 cm. The most common diagnoses were mass or malignancy at a rate of 47.6%, followed by hydatid cyst at 10.7%, pleural effusion at 7.3%, and pectus excavatum at 6.4%. Other diagnoses such as pneumothorax, thymoma, empyema, bronchiectasis, diaphragmatic hernia, and interstitial lung disease were seen at lower rates. 86.3% of the patients underwent VATS and 13.7% underwent thoracotomy. The mean surgical time was calculated as 168.65 ± 69.24 minutes. When intraoperative analgesia methods were evaluated, fentanyl was applied to 70% of the patients, remifentanil to 15%, and epidural analgesia to 15% (Table 1).



TEA: Thoracic Epidural Analgesia; TPVB: Thoracic Paravertebral Block; SAPB: Serratus Anterior Plane Block; ESPB: Erector Spinae Plane Block; PSP: Pectoserratus Plane; EOI: External Oblique Intercostal; PCA: Patient Controlled Analgesia; IV: Intravenous

Fig. 1. Flowchart.

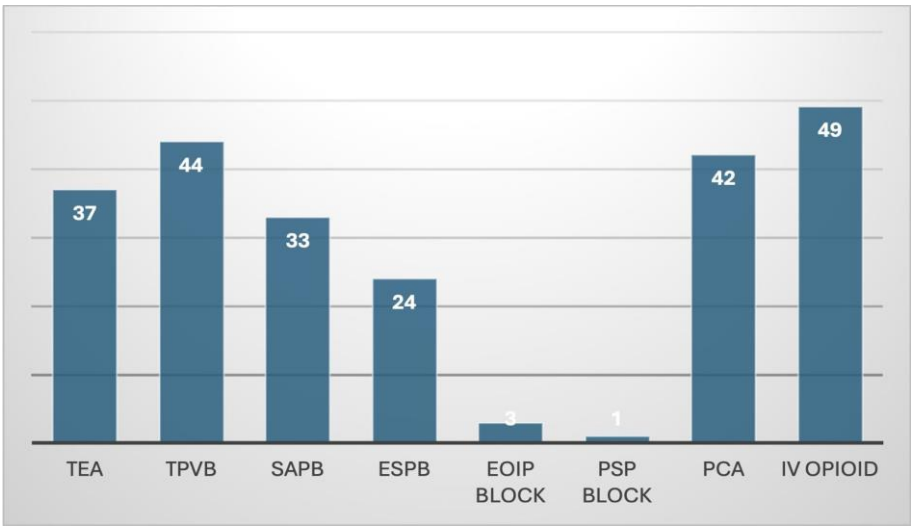


Fig. 2. Postoperative analgesia distribution.

Table 1. General characteristics of the patients.

Total patients	233 (100)
Gender	
• Female	118 (50.6)
• Male	115 (49.4)
Age (years)	48.96 ± 17.85
Weight (kg)	73.27 ± 15.90
Height (cm)	167.24 ± 10.92
ASA	
• 1	69 (29.6)
• 2	89 (38.2)
• 3	59 (25.3)
• 4	16 (16)
Diagnosis	
• Mass, malignancy	111 (47.6)
• Hydatid cyst	25 (10.7)
• Pleural effusion	17 (7.3)
• Pectus excavatum	15 (6.4)
• Thymoma	14 (6.0)
• Pneumothorax	13 (5.6)
• Esophageal duplication cyst	10 (4.3)
• Empyema	3 (1.3)
• Bronchiectasis	7 (3.0)
• Diaphragmatic eventration	2 (0.9)
• Diaphragmatic hernia	7 (3.0)
• Hyperhidrosis	4 (1.7)
• Interstitial lung disease	2 (0.9)
• Esophageal diverticulum	2 (0.9)
• Paracardiac cyst	1 (0.4)
Type of surgery	
• VATS	201 (86.3)
• Thoracotomy	32 (13.7)
Surgical duration	168.65 ± 69.24
Intraoperative analgesia	
• Fentanyl	163 (70)
• Remifentanil	35 (15)
• Epidural analgesia	35 (15)
Type of postoperative analgesia	
• TEA	37 (15.9)
• TPVB	44 (18.9)
• SAPB	33 (14.2)
• ESPB	24 (10.3)
• EOI PLANE BLOK	3 (1.3)
• PSP BLOCK	1 (0.4)
• PCA	42 (18)
• IV OPIOID	49 (21)
Need for rescue analgesia (Yes/No)	186 (79.2) / 47 (20.2)
Time to first postoperative opioid requirement (hours)	12.08 ± 9.85
Duration of hospital stay (days)	8.96 ± 4.75

VATS: Video Assisted Thoracoscopic Surgery; TEA: Thoracic Epidural Analgesia; TPVB: Thoracic Paravertebral Block; SAPB: Serratus Anterior Plane Block; ESPB: Erector Spinae Plane Block; PSP: Pectoserratus Plane; EOI: External Oblique Intercostal; PCA: Patient Controlled Analgesia; IV: Intravenous.

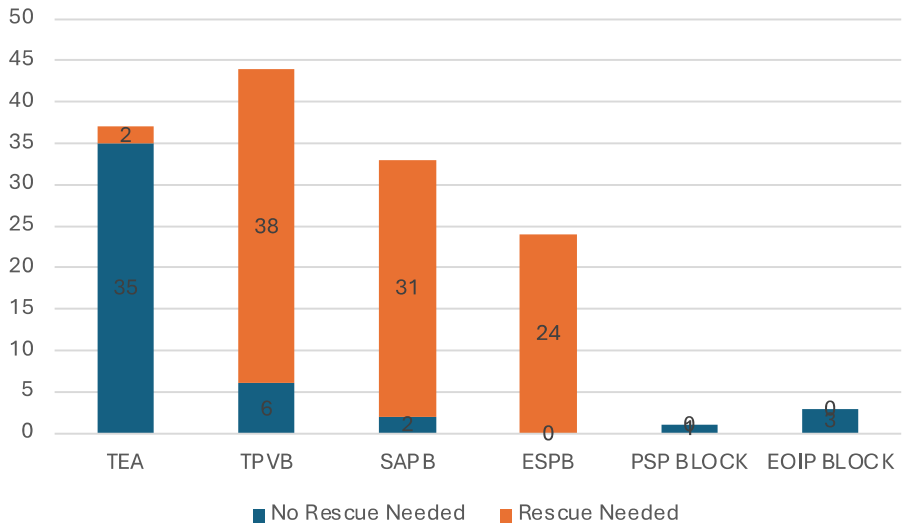


Fig. 3. Rescue analgesia requirement.

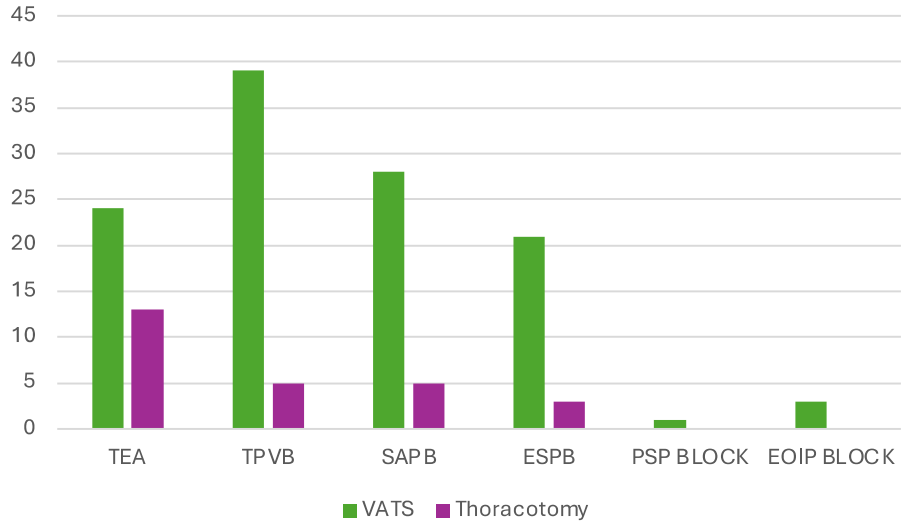


Fig. 4. Analgesia choice based on surgery type.

When we look specifically at ASA-4 patients, we see that all of these patients were diagnosed with a mass or malignancy. Of these 16 patients, 10 underwent VATS and 6 underwent thoracotomy. When we look at the analgesia management of these patients, 6 underwent PCA, 5 underwent epidural analgesia, and 5 underwent TPVB. When we look at rescue analgesia needs, it was observed that 12 patients, except for the 4 patients who underwent epidural analgesia, required rescue analgesia.

The most frequently used technique among postoperative analgesia methods was TPVB at a rate of 18.9%. This was followed by TEA at a rate of 15.9%, SAPB at a rate of 14.2%, and ESPB at a rate of 10.3%. PSP block at a rate of 0.4% and EOI plane block at a rate of 1.3% were applied less frequently. PCA was preferred at a rate of 18% and intravenous opioid administration at a rate of 21%. While 79.2% of the patients required additional rescue analgesia, the first opioid requirement occurred after an average of 12.08 ± 9.85 hours. The average hospital stay was calculated as 8.96 ± 4.75 days (Table 1).

When the effect of postoperative analgesia methods on the need for additional analgesia was evaluated, it was seen that 94.6% of the patients who underwent TEA did not require additional analgesia. In contrast, 86.4% of the patients who underwent TPVB, 93.9% of the patients who underwent SAPB and all of the patients who underwent ESPB required rescue analgesia. No additional analgesia was required in a single patient who underwent PSP block, and no additional analgesia was required in any of the three patients who underwent external oblique block (Table 2).

When the types of postoperative analgesia applied were evaluated according to the surgical method, it was seen that epidural analgesia was mostly used in patients who underwent thoracotomy (40.6%). In contrast, the most frequently preferred regional analgesia method in patients who underwent VATS was TPVB with a rate of 19.4%. It was determined that fascial plane blocks such as SAPB and ESPB were mostly preferred in VATS patients and were used less in patients who underwent thoracotomy. Methods such as EOI block and PSP block were applied quite rarely (Table 3).

Table 2. Comparison of postoperative analgesia type and rescue analgesia need.

Count of patients		Type of postoperative analgesia					
		TEA	TPVB	SAPB	ESPB	PSP blok	EOI plane blok
Need for rescue analgesia	No	35	6	2	0	1	3
	Yes	2	38	31	24	0	0

TEA: Thoracic Epidural Analgesia; TPVB: Thoracic Paravertebral Block; SAPB: Serratus Anterior Plane Block; ESPB: Erector Spinae Plane Block; PSP: Pectoserratus Plane; EOI: External Oblique Intercostal.

Table 3. Relationship between type of surgery and type of postoperative analgesia applied.

Count of patients		Type of postoperative analgesia					
		TEA	TPVB	SAPB	ESPB	PSP blok	EOI plane blok
Type of surgery	VATS	24	39	28	21	1	3
	Thoracotomy	13	5	5	3	0	0

VATS: Video Assisted Thoracoscopic Surgery; TEA: Thoracic Epidural Analgesia; TPVB: Thoracic Paravertebral Block; SAPB: Serratus Anterior Plane Block; ESPB: Erector Spinae Plane Block; PSP: Pectoserratus Plane; EOI: External Oblique Intercostal.

4. Discussion

These findings show that regional anesthesia techniques are widely used in the management of analgesia after thoracic surgery. Regional techniques such as epidural analgesia and paravertebral block have been observed to be effective in reducing opioid requirements. It shows that epidural analgesia is the most effective method in postoperative pain control. (Table-2) It is seen that epidural analgesia is at the forefront in patients who have undergone thoracotomy and less invasive regional techniques are at the forefront in VATS patients. (Table-3)

It has been observed that analgesia preference changes according to the type of surgery in postoperative pain management after thoracic surgery and TEA is the most commonly used analgesic method in patients undergoing thoracotomy. However, the more frequent use of analgesic methods such as TPVB and SAPB in VATS patients indicates that less invasive approaches are preferred in these patients. When evaluated in terms of rescue analgesia need, epidural analgesia stood out as the most successful method with the lowest additional analgesia need.

In this study, analgesia methods used in thoracic surgery operations performed in our hospital in the last year were evaluated retrospectively. Our findings show that the multimodal analgesia approach is widely adopted and that regional anesthesia techniques such as TEA and TPVB provide effective pain control.

Studies have shown that TEA and TPVB are the most powerful analgesia methods after thoracic surgery and reduce postoperative pulmonary complications [6,7]. In our study, we understand that postoperative pain scores were lower in patients who received epidural analgesia and that rescue analgesia was not required. However, it is also known that epidural analgesia may not be suitable for every patient due to side effects such as hypotension, urinary retention and motor block [8]. As an alternative regional method, TPVB has been found to be effective in both providing pain control and reducing systemic opioid requirements [9]. In our study, it was observed that the need for opioids decreased in patients who underwent TPVB. Fascial plane blocks such as SAPB and ESPB are increasingly preferred because they are less invasive and have low complication risks [10, 11]. Our findings show that these blocks are also preferred, albeit slightly, in postoperative analgesia management. However, since regional anesthesia techniques cannot be applied in some patients, PCA or intravenous opioid applications have been used. It has been stated that opioid consumption is more controlled in patients using PCA, but opioid-related side effects can still be seen [12]. In our study, the need for rescue analgesia was 79.2%, indicating that some patients require additional pain management despite multimodal analgesia.

5. Limitations

Our study has some limitations. First, it has a retrospective design and was performed with data obtained from retrospective patient records, which may lead to limitations such as missing records and incomplete reporting of some clinical variables. In addition, when evaluating the effectiveness of postoperative analgesia methods, pain scores (VAS scores) were not directly analyzed, which makes it difficult to clearly compare the differences between the methods. Chronic postoperative pain may develop in some patients after thoracic surgery [13]. Since there is no long-term follow-up data in our study, the effects of the applied analgesia methods on chronic postoperative pain could not be evaluated. However, the possible complications of analgesia methods were not discussed in detail, which provides limited information about their safety profiles. In addition, our study is a single-center study, and patient populations, protocols, and surgical approaches may differ from studies conducted in

different centers, which limits the generalizability of the results. Considering these limitations, future studies with a prospective design, larger patient groups, and long-term outcomes should be conducted.

6. Conclusions

TEA and TPVB stand out as effective methods in the management of analgesia after thoracic surgery. However, less invasive fascial plane blocks are also considered as safe and effective alternatives when patient-specific factors are taken into consideration. The widespread use of multimodal analgesia applications may both increase patient comfort and minimize opioid-related side effects by reducing opioid use. The findings of our study may contribute to clinical practices for the management of analgesia after thoracic surgery and help determine optimal analgesia strategies.

Acknowledgements

None declared.

Funding

The authors received no financial support for the research, authorship, and/or publication of this manuscript.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

Author Contributions

All of the authors made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; were involved in drafting the manuscript or revising it critically for important intellectual content; and gave final approval of the version to be published.

Data Availability

The datasets created and/or analyzed during the current study are not publicly available, but are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the ethics committee of Atatürk University (B.30.2.ATA.0.01.00/790). Written informed consent was obtained from the participants. All methods were performed in accordance with relevant guidelines and regulations.

REFERENCES

1. Grant MC, Crisafi C, Alvarez A, Arora RC, Brindle ME, Chatterjee S, et al. Perioperative Care in Cardiac Surgery: A Joint Consensus Statement by the Enhanced Recovery After Surgery (ERAS) Cardiac Society, ERAS International Society, and The Society of Thoracic Surgeons (STS). *Ann Thorac Surg*. **2024**;117(4):669-89.
2. Batchelor TJP, Rasburn NJ, Abdelnour-Berchtold E, Brunelli A, Cerfolio RJ, Gonzalez M, et al. Guidelines for enhanced recovery after lung surgery: recommendations of the Enhanced Recovery After Surgery (ERAS®) Society and the European Society of Thoracic Surgeons (ESTS). *Eur J Cardiothorac Surg*. **2019**;55(1):91-115.
3. Feray S, Lubach J, Joshi GP, Bonnet F, Van de Velde M. PROSPECT guidelines for video-assisted thoracoscopic surgery: a systematic review and procedure-specific postoperative pain management recommendations. *Anaesthesia*. **2022**;77(3):311-25.
4. Coşarcan SK, Erçelen Ö. The Effectiveness of Regional Analgesia Techniques in Thoracoscopic Surgeries: A Retrospective Single-Center Study. *JARSS*. **2022**;30(4):272-7.
5. Ülger G, Zengin M, Baldemir R, Alagoz A, Sazak H. Toraks cerrahisinde postoperatif analjezi yönetimi: iki yıllık deneyimlerimiz. *Turkish Journal of Clinics and Laboratory*. **2021**;12.
6. Joshi GP, Bonnet F, Shah R, Wilkinson RC, Camu F, Fischer B, et al. A systematic review of randomized trials evaluating regional techniques for postthoracotomy analgesia. *Anesth Analg*. **2008**;107(3):1026-40.
7. Romero A, Garcia JE, Joshi GP. The state of the art in preventing postthoracotomy pain. *Semin Thorac Cardiovasc Surg*. **2013**;25(2):116-24.
8. Davies RG, Myles PS, Graham JM. A comparison of the analgesic efficacy and side-effects of paravertebral vs epidural blockade for thoracotomy--a systematic review and meta-analysis of randomized trials. *Br J Anaesth*. **2006**;96(4):418-26.
9. Yeung JH, Gates S, Naidu BV, Wilson MJ, Gao Smith F. Paravertebral block versus thoracic epidural for patients undergoing thoracotomy. *Cochrane Database Syst Rev*. **2016**;2(2):Cd009121.
10. Fang B, Wang Z, Huang X. Ultrasound-guided preoperative single-dose erector spinae plane block provides comparable analgesia to thoracic paravertebral block following thoracotomy: a single center randomized controlled double-blind study. *Ann Transl Med*. **2019**;7(8):174.
11. Khalil AE, Abdallah NM, Bashandy GM, Kaddah TA. Ultrasound-Guided Serratus Anterior Plane Block Versus Thoracic Epidural Analgesia for Thoracotomy Pain. *J Cardiothorac Vasc Anesth*. **2017**;31(1):152-8.
12. Son J, Jeong H, Yun J, Jeon YJ, Lee J, Shin S, et al. Enhanced Recovery After Surgery Program and Opioid Consumption in Pulmonary Resection Surgery: A Retrospective Observational Study. *Anesth Analg*. **2023**;136(4):719-27.
13. Park SK, Yoon S, Kim BR, Choe SH, Bahk JH, Seo JH. Pre-emptive epidural analgesia for acute and chronic post-thoracotomy pain in adults: a systematic review and meta-analysis. *Reg Anesth Pain Med*. **2020**;45(12):1006-16.

Challenge Journal of Perioperative Medicine

Research Article

Early detection of acute kidney injury in critically ill burn patients: Evaluating the predictive role of serum and urinary NGAL

Izzet Alatli [a,*], Buket Kocaman Akbay [b]

[a] *Department of Anesthesiology and Reanimation, Darıca Farabi Education and Research Hospital, İstanbul, Türkiye*
[b] *Department of Algology, Antalya Training and Research Hospital, Antalya, Türkiye*

ABSTRACT

Background: Early detection of acute kidney injury (AKI) in critically ill burn patients is crucial for improving outcomes. Neutrophil gelatinase-associated lipocalin (NGAL) has emerged as a promising biomarker for early AKI detection. This study aimed to evaluate the efficacy of serum and urinary NGAL levels in predicting AKI in burn patients admitted to the intensive care unit (ICU).

Methods: A prospective observational study was conducted on 31 burn patients admitted to the burn ICU. Serum and urinary NGAL levels were measured at admission (0 hours) and at 12, 24, 36, 48, and 72 hours post-admission. AKI was defined using the RIFLE and AKIN criteria. Renal replacement therapy (RRT) requirements, mortality, and other clinical parameters were recorded. Statistical analyses were performed to assess the correlation between NGAL levels and AKI development.

Results: Of the 31 patients, 48.4% required RRT, and 45.2% died. Serum NGAL levels at 0 and 12 hours were significantly higher in patients who developed AKI ($p<0.05$). A serum NGAL cutoff of 251 ng/ml was identified as a significant predictor of AKI ($p<0.05$). Urinary NGAL levels did not show significant predictive value for AKI. Mortality was significantly associated with higher burn surface area, increased fluid requirements, and higher SOFA and APACHE II scores ($p<0.01$).

Conclusion: Serum NGAL levels are elevated early in burn patients who develop AKI, suggesting its potential as a predictive biomarker. Urinary NGAL did not show significant predictive value. Further studies with larger cohorts are needed to validate these findings and explore the role of NGAL in guiding early interventions in burn patients.

ARTICLE INFO

Article history:
Received – January 12, 2025
Revision requested – February 11, 2025
Revision received – February 16, 2025
Accepted – February 25, 2025

Keywords:
Critically ill patients
Burn
NGAL
Kidney injury
Renal replacement therapy
Mortality

Citation: Alatli I, Kocaman Akbay B. Early detection of acute kidney injury in critically ill burn patients: Evaluating the predictive role of serum and urinary NGAL. *Chall J Perioper Med.* **2025**; 3(1):8–13.

1. Introduction

Acute kidney injury (AKI) is a serious and common complication in critically ill burn patients, significantly increasing morbidity, mortality, and long-term health complications [1,2]. The kidneys are particularly vulnerable in burn injuries due to a combination of factors, including systemic inflammation, hypovolemia, nephrotoxic drug exposure, and muscle breakdown leading to rhabdomyolysis. Given the high risk of AKI in burn patients and its association with poor outcomes, early detection is crucial for guiding timely interventions and improving prognosis [3,4]. Traditionally, AKI is diagnosed using markers such as serum creatinine and urine output. However, these conventional markers have significant limitations. Serum creatinine, for instance, does not rise until substantial kidney damage has already occurred, making it a delayed rather than an early indicator of injury. Urine output, while commonly monitored, can be influenced by factors like aggressive fluid resuscitation, systemic inflammation, and changes in hemodynamics, limiting its reliability as a sole diagnostic tool. These challenges highlight the urgent need for more sensitive and specific biomarkers that can detect AKI at an

* *Corresponding author*. E-mail address: doc4161@gmail.com (I. Alatli)
ISSN: 2980-292X / DOI: https://doi.org/10.20528/cjpm.2025.01.002

earlier stage, allowing for timely therapeutic interventions.

Neutrophil gelatinase-associated lipocalin (NGAL) has emerged as a promising biomarker for the early detection of AKI. NGAL is a small protein released by renal tubular epithelial cells in response to injury, and its levels rise rapidly in both blood and urine within hours of kidney damage—long before changes in serum creatinine occur [5,6]. Previous studies have demonstrated that NGAL can predict AKI in various critically ill populations, including patients undergoing cardiac surgery, those with sepsis, and individuals with contrast-induced nephropathy [7,8]. These findings suggest that NGAL could serve as an early warning signal, enabling clinicians to initiate protective measures such as optimizing fluid management, avoiding nephrotoxic agents, and considering early renal replacement therapy (RRT) when necessary.

Despite the growing evidence supporting NGAL as a biomarker for AKI in critically ill patients, its role in burn patients remains unclear. The pathophysiology of AKI in burns differs from other settings due to the interplay of systemic inflammation, large-volume fluid shifts, direct renal insults, and tissue injury, which may alter NGAL kinetics. Additionally, there is uncertainty regarding whether serum or urinary NGAL is a more reliable predictor of AKI in this population, as factors such as increased vascular permeability and altered renal protein handling in burn-induced systemic inflammatory responses may affect urinary NGAL levels differently.

We hypothesized that NGAL levels would rise earlier than traditional AKI markers such as serum creatinine and urine output, making it a valuable tool for early detection in critically ill burn patients. Therefore, this study aimed to evaluate the predictive value of serum and urinary NGAL levels for AKI in this high-risk population. By exploring the role of NGAL in burn patients, we sought to provide new insights into early AKI diagnosis and contribute to improved clinical management strategies, ultimately leading to better patient outcomes.

2. Materials and Methods

This study was conducted at the Burn Intensive Care Unit of Dr. Lütfi Kırdar Kartal Training and Research Hospital between April 1, 2011, and April 1, 2012, with approval from the local ethics committee (KEAHEK, March 21, 2011, No: 03/11). The study was designed as a prospective analytical observational study to evaluate the effectiveness of neutrophil gelatinase-associated lipocalin (NGAL) as a biomarker for the early detection of acute kidney injury (AKI) in burn patients. Inclusion and Exclusion Criteria: Patients were eligible for inclusion if they met the following criteria: (1) age ≥18 years, (2) admission to the Burn ICU within 24 hours of burn injury, (3) TBSA burned ≥20%, and (4) informed consent provided. Exclusion criteria comprised: (1) pre-existing chronic kidney disease (CKD), (2) pregnancy or lactation, (3) incomplete clinical data, and (4) refusal to participate.

Upon admission to the hospital, patients were initially evaluated in the emergency department. Following initial interventions, they were assessed for additional trauma and clinical findings by a multidisciplinary team before being admitted to the burn intensive care unit. After routine monitoring, central venous catheterization and arterial cannulation were performed to facilitate fluid resuscitation and hemodynamic monitoring. Fluid resuscitation was initiated based on parameters such as body weight and the percentage of total body surface area (TBSA) affected by burns.

Blood and urine samples were collected at admission (0 hours) and at 12, 24, 36, 48, and 72 hours post-admission according to a standardized protocol. Concurrently, hemodynamic parameters, urine output, the volume of crystalloids and colloids administered within 72 hours, the use of inotropic agents, the duration of renal replacement therapy (RRT), and lactate and creatinine levels measured from venous blood gas samples were recorded. Urine samples collected for the study were not centrifuged, while serum samples were centrifuged at 5000 rpm for 4 minutes. The plasma fraction was then transferred to Eppendorf tubes and stored at -80 °C for further analysis.

To assess morbidity and mortality, the Sequential Organ Failure Assessment (SOFA) and Acute Physiology and Chronic Health Evaluation II (APACHE-II) scores were recorded at 24 and 48 hours. The AKIN (Acute Kidney Injury Network) and RIFLE (Risk, Injury, Failure, Loss, End-stage) criteria were used to define AKI and were evaluated at 12, 24, 36, 48, and 72 hours. NGAL levels in blood and urine samples were measured using the ELISA method (Human Neutrophil Gelatinase-Associated Lipocalin/Lipocalin-2 ELISA Kit; Adipo Bioscience, Inc., Santa Clara, USA).

2.1. Statistical analysis

Statistical analyses were performed using SPSS for Windows, version 15.0. The normality of the data distribution was assessed using the Kolmogorov-Smirnov test, and all parameters were found to be normally distributed. Descriptive statistics (mean, standard deviation, frequency) were used to summarize the data. For quantitative data, comparisons between groups were performed using the Student's t-test, while within-group comparisons were analyzed using the paired sample t-test. Qualitative data were compared using the chi-square test or Fisher's exact test, as appropriate. Sensitivity and specificity analyses were conducted to determine the optimal cutoff value for serum NGAL. Pearson's correlation test was used to evaluate relationships between variables. A p-value of <0.05 was considered statistically significant.

3. Results

The study included 31 patients (26 males, 5 females) with a mean age of 32.9 ± 17.6 years. The mean burn surface area was 51.3%, with flame burns being the most common etiology (54.8%). Inhalation injury was present in 12.9% of patients. Burn severity was predominantly second- and third-degree in all patients, with total body

surface area (TBSA) involvement ranging from 20% to 100% (mean: 51.3%). Primary Outcomes: AKI developed in 22.5% of patients based on RIFLE criteria and 18% based on AKIN criteria. Serum NGAL levels at 0 and 12 hours were significantly higher in patients who developed AKI ($p<0.05$) (Table 1, Fig. 1). A serum NGAL cutoff of 251 ng/ml was identified as a significant predictor of AKI ($p<0.05$). However, urinary NGAL levels did not show significant predictive value for AKI (Table 2, Fig. 2). Secondary Outcomes: RRT was required in 48.4% of patients, with a mean duration of 6.3 ± 4.7 days. Mortality was 45.2%, with higher burn surface area, increased fluid requirements, and higher SOFA and APACHE II scores being significant predictors of mortality ($p<0.01$). Inotropic support was required in 51.6% of patients and was associated with higher mortality ($p<0.01$) (Table 3).

Among the cohort, 17 patients were successfully discharged following recovery, whereas 14 patients succumbed to their injuries. While the types of burns varied, flame burns were the most common (n=17, 54.8%), followed by electrical burns (n=12, 38.7%), inhalation burns (n=4, 12.9%), scald burns (n=2, 6.4%), and burns caused by hot oil (n=1, 3.2%). Notably, two patients with electrical burns had no discernible entry or exit wounds. Some patients sustained combined burn injuries: three had both flame and inhalation burns, one had flame and electrical burns, and another had scald and inhalation burns.

In patients with suspected inhalation injury, clinical findings such as singed nasal hairs, soot deposition in the upper airways, mucosal hyperemia, and edema were carefully evaluated. Additionally, bedside bronchoscopy was performed by the pulmonology team to confirm the diagnosis. One patient was diagnosed with thoracic fractures due to multiple trauma.

Among the cohort, two patients had a history of coronary artery disease, diabetes mellitus, and hypertension; one patient had diabetes mellitus and hypertension; and another had schizophrenia, for which they were undergoing treatment at the time of admission following a suicide attempt. The remaining 26 patients had no known comorbidities aside from burn injuries. None of the patients had a history of chronic kidney disease.

Table 1. Relationship between serum NGAL levels and creatinine levels.

Time point	Correlation coefficient (R)	p-value
0 hour	0.433	0.015*
12 hours	0.443	0.013*
24 hours	0.140	0.454
36 hours	0.279	0.151
48 hours	0.332	0.091
72 hours	0.159	0.449

*Pearson correlation analysis
* $p<0.05$

Table 2. Relationship between urinary NGAL levels and creatinine levels.

Time point	Correlation coefficient (R)	p-value
0 hour	0.352	0.056
12 hours	0.195	0.302
24 hours	0.124	0.513
36 hours	0.211	0.282
48 hours	0.351	0.072
72 hours	0.232	0.264

Table 3. Distribution of inotropic use, mortality, and RRT.

Parameter	Presence (n)	Presence (%)	Absence (n)	Absence (%)
Inotropic use	16	51.6	15	48.4
Mortality	14	45.2	17	54.8
RRT	15	48.4	16	51.6

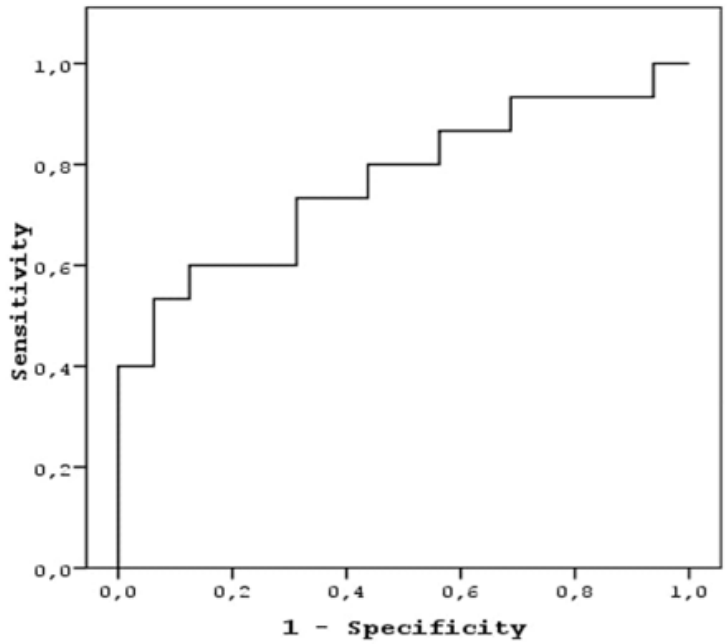


Fig. 1. ROC curve for serum NGAL: Graph representation of sensitivity vs. 1-specificity.

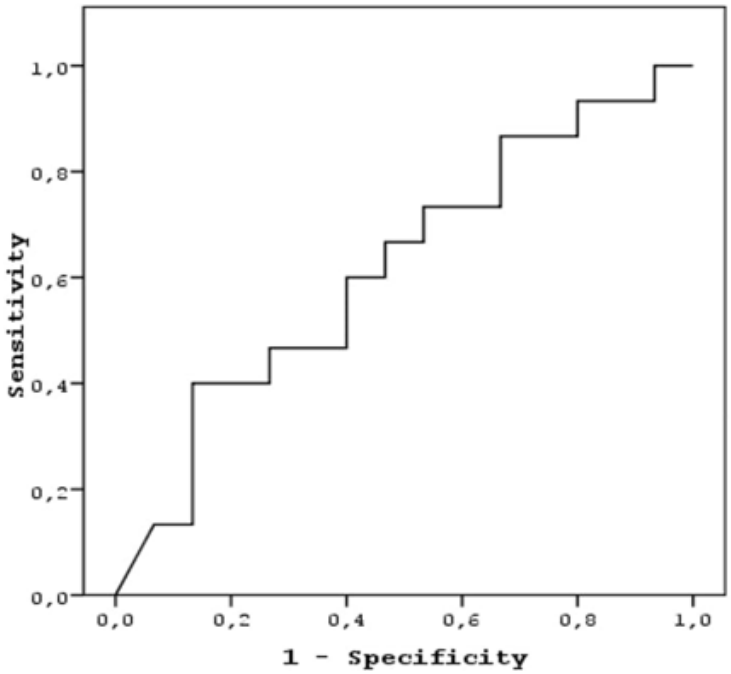


Fig. 2. ROC curve for urinary NGAL: Graph representation of sensitivity vs. 1-specificity.

4. Discussion

This study highlights that serum NGAL levels rise early in burn patients who develop acute kidney injury (AKI), suggesting its potential as a predictive biomarker. The strong correlation between serum NGAL levels and AKI development aligns with findings from other critically ill populations, such as those undergoing cardiac surgery, sepsis patients, and individuals with contrast-induced nephropathy [6,8,9]. However, urinary NGAL did not show significant predictive value in our cohort, likely due to the complex pathophysiology of burn-related AKI, which involves systemic inflammation, hypovolemia, and nephrotoxic insults [10,11].

NGAL is a small protein released from renal tubular cells in response to injury, and its levels increase rapidly in both serum and urine following AKI [5]. In our study, serum NGAL levels at admission (0 hours) and 12 hours post-admission were significantly higher in patients who developed AKI, with a cutoff value of 251 ng/ml demonstrating strong predictive accuracy ($p<0.05$). This finding is consistent with previous studies in cardiac surgery and critically ill patients, where NGAL predicted AKI 24–48 hours before serum creatinine levels rose [7,9]. The early rise in NGAL levels likely reflects tubular injury before significant changes in glomerular filtration rate (GFR) occur, making it a valuable tool for early AKI detection [6]. However, urinary NGAL did not demonstrate

significant predictive value in our cohort. This discrepancy may stem from the unique pathophysiology of burn-related AKI, which includes systemic inflammation, hypovolemia, and nephrotoxic insults [10]. Additionally, the heterogeneous nature of burn injuries and the varying degrees of severity in our cohort may have influenced the results. Further studies with larger, more homogeneous cohorts are needed to explore the role of urinary NGAL in burn patients.

The high mortality rate in our cohort (45.2%) underscores the severity of burn injuries and the critical importance of early AKI detection. AKI is a common complication in burn patients, with reported incidences ranging from 1% to 36%, depending on the population and diagnostic criteria used [12,13]. In our study, nearly half of the patients (48.4%) required renal replacement therapy (RRT), highlighting the urgent need for early identification and intervention in this population.

The association between higher SOFA and APACHE II scores and mortality emphasizes the role of multi-organ dysfunction in burn-related outcomes. Patients with larger burn surface areas and increased fluid requirements were more likely to develop AKI and require RRT, consistent with previous studies. Early identification of high-risk patients using biomarkers like NGAL could facilitate timely interventions, such as optimizing fluid management, avoiding nephrotoxic agents, and initiating RRT when indicated.

5. Limitations

This study has several limitations. Its single-center design and small sample size limit the generalizability of the findings. Additionally, the heterogeneous nature of burn injuries and the inclusion of patients with varying degrees of severity may have influenced the results. The lack of a standardized protocol for RRT initiation and the use of different RRT modalities (e.g., continuous vs. intermittent) may also have affected outcomes. Future studies should aim to include larger, more homogeneous cohorts and standardize RRT protocols to better evaluate the predictive value of NGAL in burn patients. Further research is needed to validate the role of NGAL in guiding early interventions in burn patients. Studies should explore the utility of NGAL in combination with other biomarkers, such as cystatin C, kidney injury molecule-1 (KIM-1), and interleukin-18 (IL-18), to improve the accuracy of AKI prediction [9, 14]. Additionally, the impact of early interventions guided by NGAL levels on patient outcomes, such as mortality, length of ICU stay, and long-term renal function, should be investigated.

6. Conclusions

Serum NGAL is a promising biomarker for early AKI detection in burn patients. Its ability to predict AKI before significant changes in serum creatinine makes it a valuable tool for early intervention. However, urinary NGAL did not show significant predictive value in our cohort, likely due to the complex pathophysiology of burn-related AKI. Further studies with larger cohorts are needed to validate these findings and explore the role of NGAL in guiding early interventions in burn patients.

Acknowledgements

None declared.

Funding

The authors received no financial support for the research, authorship, and/or publication of this manuscript.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

Author Contributions

All of the authors made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; were involved in drafting the manuscript or revising it critically for important intellectual content; and gave final approval of the version to be published.

Data Availability

The datasets created and/or analyzed during the current study are not publicly available, but are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the local ethics committee of Dr. Lütfi Kırdar Kartal Training and Research Hospital (KEAHEK, March 21, 2011, No: 03/110). Written informed consent was obtained from the participants. All methods were performed in accordance with relevant guidelines and regulations.

REFERENCES

1. Palmieri T, Lavrentieva A, Greenhalgh DG. Acute kidney injury in critically ill burn patients. Risk factors, progression and impact on mortality. *Burns*. **2010**;36(2):205-11.
2. Witkowski W, Kawecki M, Surowiecka-Pastewka A, Klimm W, Szamotulska K, Niemczyk S. Early and Late Acute Kidney Injury in Severely Burned Patients. *Med Sci Monit*. **2016**;22:3755-63.
3. Park J, Kym D, Kim M, Cho YS, Hur J, Chun W, et al. Pioneering predictions of AKI and AKIN severity in burn patients: a comprehensive CBC approach. *Sci Rep*. **2024**;14(1):675.
4. Emami A, Javanmardi F, Rajaee M, Pirbonyeh N, Keshavarzi A, Fotouhi M, et al. Predictive Biomarkers for Acute Kidney Injury in Burn Patients. *J Burn Care Res*. **2019**;40(5):601-5.
5. Nickolas TL, O'Rourke MJ, Yang J, Sise ME, Canetta PA, Barasch N, et al. Sensitivity and specificity of a single emergency department measurement of urinary neutrophil gelatinase-associated lipocalin for diagnosing acute kidney injury. *Ann Intern Med*. **2008**;148(11):810-9.
6. Devarajan P. Emerging biomarkers of acute kidney injury. *Contrib Nephrol*. **2007**;156:203-12.
7. Wagener G, Gubitosa G, Wang S, Borregaard N, Kim M, Lee HT. Urinary neutrophil gelatinase-associated lipocalin and acute kidney injury after cardiac surgery. *Am J Kidney Dis*. **2008**;52(3):425-33.
8. Mishra J, Ma Q, Kelly C, Mitsnefes M, Mori K, Barasch J, et al. Kidney NGAL is a novel early marker of acute injury following transplantation. *Pediatr Nephrol*. **2006**;21(6):856-63.
9. Haase M, Bellomo R, Devarajan P, Schlattmann P, Haase-Fielitz A. Accuracy of neutrophil gelatinase-associated lipocalin (NGAL) in

diagnosis and prognosis in acute kidney injury: a systematic review and meta-analysis. *Am J Kidney Dis*. **2009**;54(6):1012-24.
10. Srisawat N, Lawsin L, Uchino S, Bellomo R, Kellum JA. Cost of acute renal replacement therapy in the intensive care unit: results from The Beginning and Ending Supportive Therapy for the Kidney (BEST Kidney) study. *Crit Care*. **2010**;14(2):R46.
11. Cruz DN, de Cal M, Garzotto F, Perazella MA, Lentini P, Corradi V, et al. Plasma neutrophil gelatinase-associated lipocalin is an early biomarker for acute kidney injury in an adult ICU population. *Intensive Care Med*. **2010**;36(3):444-51.
12. Mustonen KM, Vuola J. Acute renal failure in intensive care burn patients (ARF in burn patients). *J Burn Care Res*. **2008**;29(1):227-37.
13. Chung KK, Juncos LA, Wolf SE, Mann EE, Renz EM, White CE, et al. Continuous renal replacement therapy improves survival in severely burned military casualties with acute kidney injury. *J Trauma*. **2008**;64(2 Suppl):S179-85; discussion S85-7.
14. Parikh CR, Jani A, Mishra J, Ma Q, Kelly C, Barasch J, et al. Urine NGAL and IL-18 are predictive biomarkers for delayed graft function following kidney transplantation. *Am J Transplant*. **2006**;6(7):1639-45.

Challenge Journal of Perioperative Medicine

Review

Neuraxial anesthesia in pregnant patients with neurological disorders – Safety and practice strategies: A review

Mehmet Akif Yilmaz [a,*], Nuray Uzun [a]

[a] *Department of Anesthesiology and Reanimation, Atatürk University School of Medicine, Erzurum, Türkiye*

ABSTRACT

Pregnant patients with neurological disorders face multifaceted challenges arising from both the physiological changes of pregnancy and the underlying neurological conditions. In this unique patient population, anesthesia management requires meticulous planning to ensure maternal and fetal safety while minimizing the risk of neurological complications. Neuraxial anesthesia emerges as a safe and effective option when implemented with appropriate patient selection, a multidisciplinary approach, and individualized anesthesia protocols. This review comprehensively evaluates the clinical benefits of neuraxial anesthesia in pregnant patients with neurological disorders, highlighting critical considerations in its application and potential risks. Drawing upon the existing body of evidence, it aims to promote the safe use of neuraxial techniques and enhance awareness of the challenges inherent in managing this patient group. Additionally, the review underscores the importance of anesthesiologists adopting individualized strategies that address the specific risks associated with neurological pathologies, optimizing the advantages of neuraxial anesthesia in obstetric care.

ARTICLE INFO

Article history:
Received – December 16, 2024
Revision requested – February 6, 2025
Revision received – February 7, 2025
Accepted – February 10, 2025

Keywords:
Neurologic disorder
Pregnancy complications
Anesthesia obstetrical
Anesthesia epidural
Anesthesia spinal

Citation: Yilmaz MA, Uzun N. Neuraxial anesthesia in pregnant patients with neurological disorders – Safety and practice strategies: A review. *Chall J Perioper Med.* **2025**; 3(1):14–20.

1. Introduction

Obstetric patients can present with a broad range of neurological disorders. Most of the literature on anesthesia management in such cases consists of case reports or retrospective analyses involving a limited number of patients. In this article, we will review the literature and try to give a general summary about pregnant women with neurological disorders. After discussing labor analgesia and cesarean section anesthesia, general considerations for pregnant women with neurological disorders will be discussed and anesthetic management will be summarized.

2. Anesthetic Considerations and Neurologic Disorders

2.1. Labor pain

Pain perception is influenced by a person's emotional state, motivations, cognitive processes, and social and cultural context [1]. Many women, particularly those experiencing childbirth for the first time, describe labor pain as intolerable [2]. In the 2019 obstetric analgesia and anesthesia guidelines published by the American College of Obstetricians and Gynecologists, it is stated that maternal request alone is a valid medical indication for labor analgesia. Additionally, they concluded that neuraxial labor analgesia does not lead to a higher rate of cesarean deliveries [3]. Pain during the first stage of

* *Corresponding author*. E-mail address: mehmetakifyilmaz025@gmail.com (M. A. Yilmaz)
ISSN: 2980-292X / DOI: https://doi.org/10.20528/cjpm.2025.01.003

labor is classified as visceral pain. It is caused by the stretching of mechanoreceptors in the uterus and cervix, as well as tissue ischemia. The visceral pain signals are carried to the spinal cord through the T10, T11, T12, and L1 nerve roots. The pain experienced during the second stage of labor is more intense than that of the first stage. The pain during the second stage of labor is a combination of visceral pain from uterine contractions and cervical distension, along with somatic pain caused by the stretching of the vaginal and perineal tissues. The somatic pain signals are transmitted to the spinal cord through the pudendal nerve (S2, S3, and S4) [4].

2.2. Effects of labor pain

Labor causes a neuroendocrine stress response that has effects on multiple maternal and fetal organ systems. Labor pain increases oxygen consumption, so pregnant women who hyperventilate may experience respiratory alkalosis due to hypocarbia [5]. The resulting hypocarbia can inhibit ventilatory drive and cause maternal and fetal hypoxemia in the absence of supplemental oxygen [6]. Respiratory alkalosis shifts the oxyhemoglobin curve to the left, increasing the affinity of oxygen for maternal hemoglobin and thus reducing the transfer of oxygen from the placenta to the fetus. Severe maternal alkalosis can cause uteroplacental vasoconstriction, leading to decreased fetal blood flow and oxygen delivery [7]. Epidural analgesia reverses the adverse ventilatory effects of pain, resulting in increased oxygen tension in both mother and fetus [8]. Increased plasma catecholamines secondary to pain increase peripheral vascular resistance and reduce uteroplacental perfusion [9]. Using analgesia during labor reduces the endocrine stress response of the mother and baby [10].

2.3. Labor analgesia

Multiple pharmacologic and nonpharmacologic options are available to help women manage pain during labor. Neuraxial analgesic techniques [i.e., epidural, spinal, and combined spinal-epidural] are the most effective way to alleviate labor pain [11]. The use of neuraxial analgesia is recommended to manage labor pain when there are no contraindications [12]. The most commonly used systemic labor analgesics are opioids and opioid agonist-antagonists [13]. These include fentanyl, remifentanil, meperidine, morphine, nalbuphine, butorphanol, and pentazocine [14]. In addition to opioids, antihistamines, phenothiazine derivatives, benzodiazepines, or anesthetic gases can be used. These are promethazine, hydroxyzine, ketamine, midazolam, diazepam, and nitrous oxide [15].

2.4. Neuraxial analgesia and anesthesia in patients with neurological disorders

Neuraxial analgesia and anesthesia techniques are the preferred options for providing labor pain relief and anesthesia during cesarean delivery in obstetric patients. Neurological disorders affect the choice of technique in anesthesia management. We have some general concerns for all patients with neurological or neuromuscular disorders. For instance, in patients with elevated intracranial pressure caused by an intracarinal mass or other factors, there is a risk of a rapid drop in cerebrospinal fluid (CSF) pressure and potential brain herniation following neuraxial anesthesia. Additionally, distorted anatomy may complicate both neuraxial anesthesia and airway management.

2.5. When should we perform premedication? What should we pay attention to?

Patients with neurological disorders should be premedicated well before delivery. Previous records, including imaging studies, should be examined, and a multidisciplinary management plan should be developed if needed. For obstetric patients, this plan should address labor analgesia or anesthesia for cesarean delivery. The preanesthetic consultation provides the patient with an opportunity to weigh the risks and benefits of different anesthesia options. It is also important to review the current treatment regimen, including medications that might impact anesthesia management. Neurological symptoms such as cognitive dysfunction or seizures should be questioned for frequency and severity. The effects of neurological disease on other organs and systems (e.g. heart, lung) should be evaluated.

2.6. Intracranial mass

Patients with brain tumors may require anesthesia for procedures other than craniotomy. The primary concern is that a reduction in lumbar cerebrospinal fluid (CSF) pressure, caused by a dural puncture—whether intentional with a spinal needle or accidental with an epidural needle—can increase the risk of brain tissue herniation. There is also a risk of a potentially dangerous increase in intracranial pressure after the administration of large volumes or bolus doses of epidural fluid [16]. In a retrospective study conducted by Girault et al. [16], 20 women with intracranial masses [primary or metastasis] were examined. They underwent vaginal delivery or cesarean section with neuraxial analgesia and anesthesia. It has been shown that the type of birth is not associated with maternal mortality. The case report published by Finder et al. [17] reported three patients managed with epidural anesthesia: two with vaginal birth and one with cesarean section. No complications were observed related to the anesthesia technique. A 29-week-old pregnant woman with giant intracranial meningioma, reported by Kasper et al. [18], was admitted to the hospital with speech disorder. In the imaging performed, an intracranial mass covering more than 50% of the right hemisphere was detected in the transverse section. As a result of a multidisciplinary approach, a cesarean section was performed with epidural anesthesia to monitor consciousness. No complications related to the anesthesia method were observed.

A neurological or neurosurgical consultation should be obtained whenever possible before administering neuraxial anesthesia in patients with intracranial masses. The consultant should be specifically asked

whether a dural puncture could cause brain herniation. Neuroimaging should be reviewed to assess for mass effect, hydrocephalus, and potential obstruction of cerebrospinal fluid (CSF) flow. If there is clinical and radiological evidence of significant mass effect or CSF flow obstruction, the patient may be at an elevated risk of brain herniation following a dural puncture, and neuraxial anesthesia should be avoided. For patients considered to be at a lower risk of brain herniation, the risks and benefits of neuraxial anesthesia should be discussed among the neurologist, obstetrician, anesthesiologist, and the patient.

In patients with intracranial masses, general anesthesia may be necessary for an emergency or elective cesarean section when neuraxial anesthesia is contraindicated. In patients with elevated intracranial pressure, opioids are commonly given alongside anesthesia induction agents during endotracheal intubation to prevent hypertension and increased intracranial pressure that may result from sympathetic discharge [19]. During anesthesia induction for a cesarean section, the advantages of using opioids must be weighed against the risk of neonatal respiratory depression, as all opioids pass through the placenta [20]. Remifentanil is a desirable option due to its rapid onset and ultra-short duration of action, which allow for quick emergence and smooth extubation. In the prospective, randomized, controlled study titled Effects of remifentanil on mother and newborn during the induction of general anesthesia, conducted by Kee et al. [21] on 40 cesarean section patients: 2 newborns in the study group required naloxone administration due to respiratory depression. Kee says remifentanil crosses the placenta and may cause neonatal depression and recommends using remifentanil when adequate facilities for neonatal resuscitation are available. In addition, during general anesthesia, $PaCO_2$ (partial carbon dioxide) should be kept within the normal range. Increases in PaCO2 will cause increased cerebral blood flow, and hypercarbia should always be prevented in patients with increased ICP [22]. Hyperventilation and hypocarbia should also be avoided, as severe hyperventilation can lead to cerebral vasoconstriction and reduced cerebral perfusion. In pregnant patients, it can also cause uterine artery vasoconstriction, leading to decreased blood flow to the fetus [23].

2.7. Idiopathic intracranial hypertension (IIH)

Also referred to as pseudotumor cerebri, this condition is characterized by high intracranial pressure without the presence of a space-occupying lesion or ventriculomegaly. Idiopathic intracranial hypertension (IIH) can get worse during pregnancy. The most serious outcome is the risk of permanent vision loss. There is generally no risk of brain herniation after dural puncture in patients with IIH, and in fact CSF drainage can be used therapeutically in patients with IIH [24]. In the case report published by Gragasin et al. [25], while epidural anesthesia was applied to a pregnant woman with IIH diagnosis for labor analgesia, the catheter sent to the intrathecal space after involuntary dural puncture was used both for labor analgesia and for CSF aspiration in the treatment of severe postpartum headaches. In the case report published by Moore et al. [26], an intrathecal catheter was placed to treat postoperative intracranial hypertension in a pregnant woman diagnosed with IIH. In the case reports published by Palop et al. [27], it was presented that epidural anesthesia technique was chosen for labor analgesia in two pregnant women diagnosed with IIH. They suggested that especially epidural bolus doses should be given slowly to avoid increasing intracranial pressure. In the case report published by Bedson et al. [28], they presented the combined spino-epidural technique for cesarean section anesthesia to a pregnant woman diagnosed with IIH. No complications related to the choice of anesthesia technique were observed in all of these case reports. In the case report published by Estevez et al. [29], they presented a patient with IIH who experienced acute vision loss while applying an epidural blood patch, and attributed the bilateral vitreal and retinal hemorrhage to the increased intracranial pressure caused by the rapid application of the epidural blood patch. As a result, neuraxial anesthesia can be applied carefully in pregnant women with IIH. The advantage of continuous spinal anesthesia is that it reduces the increased intracranial pressure that becomes symptomatic through CSF aspiration. Continuous spinal anesthesia is not typically used for labor analgesia, but it may be considered for patients IIH who are at high risk for cesarean delivery. The use of a small volume of spinal anesthetic enables rapid, titratable surgical anesthesia, removing the need for a large, quick epidural bolus in the event of an urgent operative delivery. Additionally, it can be utilized to drain cerebrospinal fluid (CSF) in patients who develop symptoms of increased intracranial pressure (ICP) during or after labor. In the case report by Aly et al. [30], a pregnant woman diagnosed with IIH presented to the hospital for delivery and presented with symptoms of intracranial hypertension such as severe headache, nausea and vomiting. After a voluntary intrathecal catheter was placed and 25 cc CSF aspiration was performed, the patient's symptoms were relieved and intrathecal labor analgesia was started.

2.8. Cerebrovascular disorders (CVD) (ischemic or hemorrhagic stroke)

Ischemic or hemorrhagic stroke occurs in 30 per 100,000 women during pregnancy. In the case of acute stroke, surgery should be postponed whenever possible because adverse outcomes are likely to increase [31]. There is limited data to predict the risks in pregnant patients with a recent stroke. Management is based on the patient's clinical condition and the urgency of delivery. Neuraxial anesthesia techniques are preferred for pain management during delivery, unless contraindicated due to anticoagulation or the effects of a cerebrovascular disorder (CVD) on intracranial anatomy and physiology. For cesarean delivery, neuraxial anesthesia should be considered whenever feasible to reduce circulating catecholamines and minimize blood pressure fluctuations associated with intubation and extubation [32]. In a case report published by Wang et al. [32], a cesarean section is indicated for a pregnant woman with hemorrhagic

stroke after a multidisciplinary approach and the patient is administered epidural anesthesia. No procedure-related complications are observed. In the review titled "Stroke in Pregnancy" published by Miller et al. [31] in 2020, it was suggested that vaginal delivery should be the first choice for delivery, and neuraxial methods were also recommended as the first choice for labor analgesia. It has been suggested that neuraxial anesthesia should be the first choice anesthesia method for patients who are indicated for cesarean section with a multidisciplinary approach. It is emphasized that general anesthesia should be performed if therapeutic anticoagulants are used, neurosurgical surgery is planned, or neuraxial anesthesia is contraindicated. In patients with ischemic stroke who need antithrombotic or anticoagulant therapy for prevention or treatment, neuraxial anesthesia techniques must be coordinated with the timing of drug administration. In some cases, neuraxial anesthesia should be avoided due to the risk of epidural hematoma.

2.9. Intracranial aneurysm and arteriovenous malformation (AVM)

There is no need to alter the standard anesthesia management for patients who have undergone complete surgical repair of an intracranial aneurysm or arteriovenous malformation (AVM). For patients with residual or untreated lesions, a multidisciplinary plan for obstetric anesthesia management should be developed, aiming to prevent rupture of the lesion [33]. The main concern in anesthetic management is to prevent hypertension, as it can raise the pressure gradient across the lesion wall and lead to rupture. This increase in pressure gradient and potential rupture can occur after a dural puncture during a neuraxial procedure, but could also theoretically result from a sudden drop in cerebrospinal fluid (CSF) pressure [34]. In a retrospective study published by Elwood et al. [33] in 2020, 16 pregnant women with arteriovenous malformation were screened; 13 of them required anesthesia for cesarean section and one required anesthesia for labor pain. Of these, 11 pregnant women received spinal anesthesia and 2 received epidural anesthesia. One pregnant woman received epidural anesthesia as labor analgesia. In their case series of 16 births, no complications were seen directly resulting from neuraxial procedures. The decision to use neuraxial techniques for labor analgesia or cesarean delivery should weigh the risks and benefits of these methods in comparison to alternatives. For obstetric patients, neuraxial techniques are typically recommended for those with known intracranial aneurysms and arteriovenous malformations (AVMs). Neuraxial labor analgesia is more effective in reducing the rise in blood pressure during labor compared to alternative methods of pain relief [34]. Neuraxial anesthesia facilitates instrumental vaginal delivery and reduces the need for general anesthesia during cesarean delivery. The risk of significant intracranial hypotension after a dural puncture can be minimized by using a small-bore, pencil-point spinal needle. Epidural analgesia typically prevents dural puncture, but if an inadvertent dural puncture occurs with the larger epidural needle, cerebrospinal fluid (CSF) leakage may be more significant compared to a small-bore spinal needle. General anesthesia eliminates the risk of dural puncture but necessitates endotracheal intubation, which can be complicated by hypertension during both intubation and extubation. Additionally, the risks associated with general anesthesia apply to all obstetric patients [33]. In patients with intracranial vascular lesions who develop a headache following a neuraxial anesthesia procedure, there should be a strong suspicion of intracranial hemorrhage when assessing the patient for a potential post-dural puncture headache (PDPH). For these patients, intracranial hemorrhage should be ruled out before performing an epidural blood patch to treat a PDPH. In the case report published by Egger et al., intracranial hemorrhage was detected in the imaging performed after severe headaches following spinal anesthesia in a pregnant woman with known AVM diagnosis [35].

2.10. Spinal cord anomalies

2.10.1. Chiari malformation

Chiari malformations are congenital conditions marked by abnormalities at the craniocervical junction, leading to the downward displacement of cerebellar structures and the potential for partial or intermittent obstruction of cerebrospinal fluid flow [36]. Most pregnant patients have Chiari type 1, characterized by the displacement of an abnormally shaped cerebellum below the level of the foramen magnum [37]. Key anesthesia-related concerns include the extent of obstruction or potential obstruction of cerebrospinal fluid (CSF) flow between the cranial and spinal compartments, as well as the risk of herniation following a dural puncture [38]. Twelve pregnant women with type 1 Chiari malformation were followed by Chantigan et al. [37]; general anesthesia was applied to 3 pregnant women, epidural anesthesia was applied to 6 pregnant women, and spinal anesthesia was applied to 3 pregnant women. It was stated that neuraxial anesthesia is safe in pregnant women with type 1 Chiari malformation. Landau et al.'s [38] published case report emphasized that spinal anesthesia was applied to a pregnant woman with surgically corrected Chiari type 1 malformation without any complications. In a study titled "Management of Anesthesia and Delivery in Women with Chiari I Malformations" published by Waters et al. [39] in 2018, they showed that no complications associated with neuraxial anesthesia developed. In this article, the author stated that there should be no complications in patients who receive epidural or spinal anesthesia, and that the neuraxial option should be offered to women with Chiari malformation.

2.10.2. Spinal abnormalities

Patients with cervical spine disorders may face an increased risk of airway management difficulties during general anesthesia, due to factors such as progressive kyphosis or limited mobility following corrective spine surgery [40]. Patients with spinal abnormalities may have difficult neuraxial procedures, increasing the risk of inadvertent dural puncture during epidural anesthesia

[41]. Patients with these disorders should have radiological imaging to assess the relevant anatomy if neuraxial anesthesia is being considered. The feasibility of neuraxial anesthesia was demonstrated in the case report titled "A Pregnant Woman with Spina Bifida: Need for a Multidisciplinary Labor Plan" published by O'neal [41].

2.10.3. Syringomyelia

Patients with syringomyelia are theoretically at risk of syrinx dilation from a rapid epidural bolus injection or from increased intracranial pressure during intubation [42]. In a review titled "Anesthetic and Obstetric Management of Syringomyelia during Labor and Delivery" published by Garvey et al. [42], 70% of 43 pregnant women who underwent cesarean section received general anesthesia, and 69% of those who gave birth vaginally received epidural anesthesia. All anesthesia techniques were successfully performed without permanent complications.

2.10.4. Spinal stenosis or lumbar disc herniation

In a retrospective study published by Hebl et al. [43], titled "Neuraxial Anesthesia in Patients with Spinal Stenosis, Lumbar Disc Herniation or Previous Spinal Surgery", a total of 937 pregnant women were screened for neurological complications. The primary limitation of this study is that the effects of neuraxial anesthesia could not be fully evaluated, as there was no control group with similar pathology that received general anesthesia. The study indicates that patients with spinal stenosis or lumbar disc herniation may have an increased risk of neurological complications following neuraxial anesthesia. In a retrospective study by Moen et al. [44], approximately 1.7 million patients who underwent neuraxial anesthesia were screened for postoperative neurological complications, and spinal stenosis was determined to be a risk factor for postoperative neurological complications. Of the 1.7 million patients screened, only 85 patients developed permanent neurological complications.

2.10.5. Patients with shunts

Patients with functional CSF shunts may undergo general anesthesia or neuraxial anesthesia [45]. In the case report published by Bedard et al. [45], epidural anesthesia was applied to a pregnant woman with a shunt without any complications. In patients with lumboperitoneal shunts, the effect of intrathecal local anesthetic may be unpredictable and its duration of effect may be shorter due to leakage of the local anesthetic into the peritoneal cavity through the shunt. An insufficient or failed block may occur [46]. In a case report by Kaul et al. [46], on accidental spinal analgesia in an obese woman with a lumboperitoneal shunt, it was noted that the duration of the local anesthetic's effect was reduced to 10-12 minutes when labor analgesia was administered with intrathecal local anesthetic.

Table 1. Summary of diseases and neuraxial procedures.

Illness	Single dose spinal anesthesia	Epidural anesthesia	Combined spinoepidural anesthesia	Continuous spinal anesthesia	Complications	Precautions or key recommendations
Intracranial mass	Reported [47]	Reported [16–18]	No reported	No reported	Hydrocephalus due to brainstem herniation and infratentorial mass [47].	Beware of brain herniation and potential obstruction of CSF flow.
IIH	Reported [48]	Reported [27] Epidural boluses should be administered gradually and slowly [29].	Reported [28]	Reported [25,26,30]	Acute vitreous hemorrhage after rapid, high-volume epidural [29].	Continuous spinal anesthesia can be used for analgesia, anesthesia, and headache caused by IIH.
Cerebrovascular disorders	Reported [31]	Reported [31,32]	Reported [31]	Reported [31]	No complications were observed directly resulting from neuraxial procedures.	Caution with the use of therapeutic or prophylactic anticoagulants.
Intracranial aneurysm or AVM	Reported [33,35]	Reported [33]	Reported [33]	No reported	SAH after spinal anesthesia [35]	Neuraxial anesthesia is safe in the operated patient. The risk of lesion rupture should always be kept in mind.
Chiari malformation	Reported [37,39]	Reported [37,39]	Reported [5,36]	Reported [37]	No complications were observed directly resulting from neuraxial procedures.	Safety of neuraxial anesthesia in the operated patient [38].
Syringomyelia	Reported [49]	Reported [42,50]	No reported	No reported	No complications were observed directly resulting from neuraxial procedures.	High doses and rapidly administered epidural boluses may dilate the syrinx.

IIH: Idiopathic Intracarinial Hypertension; AVM: Arterio Venous Malformation; CSE: Combined Spino-Epidural; SAH: Subarachnoid Hemorrhage.

3. Conclusions

Pregnant women with neurological disorders require a multidisciplinary approach during both pregnancy and delivery. The coordinated work of the neurologist, obstetrician and anesthesiologist can ensure optimal results for both the mother and the fetus. The neurologist; to evaluate how the patient's current neurological condition will be affected by pregnancy and to monitor the disease. To determine the risk of neurological complications during pregnancy or delivery and to take the necessary precautions. In pregnant women with neurological diseases, the neurosurgeon has an important role in the management of diseases that may require surgical intervention or may lead to critical neurological conditions such as increased intracranial pressure. He/she can determine surgical risks in patients who are planned to undergo neuraxial anesthesia. Emergency surgical intervention may be recommended by the neurosurgeon. He/she plays an active role in the management of neurological disorders that develop especially in the postpartum period. The obstetrician; to monitor the course of pregnancy, evaluate maternal and fetal health, and determine the method of delivery in pregnant women with neurological diseases. To create the most appropriate birth plan for patients. The anesthesiologist; to determine the safest anesthesia method suitable for the patient's neurological condition. To evaluate the applicability of neuraxial anesthesia and consider contraindications. If general anesthesia is required, to plan the anesthesia management in a way that minimizes the effects of neurological diseases. The coordinated work of these three branches can prevent possible complications and make the birth process safe for both the mother and the baby. This review aims to demonstrate that neuraxial anesthesia can be used safely in these patient groups and may offer various advantages. With appropriate patient selection, careful evaluation and individualized anesthesia planning, neuraxial anesthesia applications can provide optimal results for both mother and baby. We aim to encourage anesthesiologists to be informed on this subject and not hesitate to apply neuraxial anesthesia to pregnant women with neurological disorders.

Acknowledgements
None declared.

Funding
The authors received no financial support for the research, authorship, and/or publication of this manuscript.

Conflict of Interest
The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

Author Contributions
All of the authors made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; were involved in drafting the manuscript or revising it critically for important intellectual content; and gave final approval of the version to be published.

Data Availability
The datasets created and/or analyzed during the current study are not publicly available, but are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate
Not applicable.

REFERENCES

1. Lowe NK. The nature of labor pain. *Am J Obstet Gynecol*. **2002**;186(5 Suppl Nature):S16-24.
2. Ranta P, Spalding M, Kangas-Saarela T, Jokela R, Hollmén A, Jouppila P, et al. Maternal expectations and experiences of labour pain--options of 1091 Finnish parturients. *Acta Anaesthesiol Scand*. **1995**;39(1):60-6.
3. ACOG Practice Bulletin No. 209: Obstetric Analgesia and Anesthesia. *Obstet Gynecol*. **2019**;133(3):e208-e25.
4. Brownridge P. The nature and consequences of childbirth pain. *Eur J Obstet Gynecol Reprod Biol*. **1995**;59 Suppl:S9-15.
5. Minnich ME, Brown M, Clark RB, Miller FC, Thompson DS. Oxygen desaturation in women in labor. *J Reprod Med*. **1990**;35(7):693-6.
6. Rooth G. Maternal hypoxaemia during labor. *Padiatr Padol*. **1982**;17(2):231-6.
7. Tomimatsu T, Kakigano A, Mimura K, Kanayama T, Koyama S, Fujita S, et al. Maternal carbon dioxide level during labor and its possible effect on fetal cerebral oxygenation: mini review. *J Obstet Gynaecol Res*. **2013**;39(1):1-6.
8. Hägerdal M, Morgan CW, Sumner AE, Gutsche BB. Minute ventilation and oxygen consumption during labor with epidural analgesia. *Anesthesiology*. **1983**;59(5):425-7.
9. Shnider SM, Wright RG, Levinson G, Roizen MF, Wallis KL, Rolbin SH, et al. Uterine blood flow and plasma norepinephrine changes during maternal stress in the pregnant ewe. *Anesthesiology*. **1979**;50(6):524-7.
10. Vogl SE, Worda C, Egarter C, Bieglmayer C, Szekeres T, Huber J, et al. Mode of delivery is associated with maternal and fetal endocrine stress response. *Bjog*. **2006**;113(4):441-5.
11. Traynor AJ, Aragon M, Ghosh D, Choi RS, Dingmann C, Vu Tran Z, et al. Obstetric Anesthesia Workforce Survey: A 30-Year Update. *Anesth Analg*. **2016**;122(6):1939-46.
12. Jones L, Othman M, Dowswell T, Alfirevic Z, Gates S, Newburn M, et al. Pain management for women in labour: an overview of systematic reviews. *Cochrane Database Syst Rev*. **2012**;2012(3):Cd009234.
13. Olofsson C, Ekblom A, Ekman-Ordeberg G, Hjelm A, Irestedt L. Lack of analgesic effect of systemically administered morphine or pethidine on labour pain. *Br J Obstet Gynaecol*. **1996**;103(10):968-72.
14. Smith LA, Burns E, Cuthbert A. Parenteral opioids for maternal pain management in labour. *Cochrane Database Syst Rev*. **2018**;6(6):Cd007396.
15. Likis FE, Andrews JC, Collins MR, Lewis RM, Seroogy JJ, Starr SA, et al. Nitrous oxide for the management of labor pain: a systematic review. *Anesth Analg*. **2014**;118(1):153-67.
16. Girault A, Dommergues M, Nizard J. Impact of maternal brain tumours on perinatal and maternal management and outcome: a single referral centre retrospective study. *Eur J Obstet Gynecol Reprod Biol*. **2014**;183:132-6.
17. Finfer SR. Management of labour and delivery in patients with intracranial neoplasms. *Br J Anaesth*. **1991**;67(6):784-7.
18. Kasper EM, Hess PE, Silasi M, Lim KH, Gray J, Reddy H, et al. A pregnant female with a large intracranial mass: Reviewing the evidence to obtain management guidelines for intracranial meningiomas during pregnancy. *Surg Neurol Int*. **2010**;1:95.
19. Bédard JM, Richardson MG, Wissler RN. General anesthesia with remifentanil for Cesarean section in a parturient with an acoustic neuroma. *Can J Anaesth*. **1999**;46(6):576-80.
20. Draisci G, Valente A, Suppa E, Frassanito L, Pinto R, Meo F, et al. Remifentanil for cesarean section under general anesthesia: effects

on maternal stress hormone secretion and neonatal well-being: a randomized trial. *Int J Obstet Anesth*. **2008**;17(2):130-6.
21. Ngan Kee WD, Khaw KS, Ma KC, Wong AS, Lee BB, Ng FF. Maternal and neonatal effects of remifentanil at induction of general anesthesia for cesarean delivery: a randomized, double-blind, controlled trial. *Anesthesiology*. **2006**;104(1):14-20.
22. Imarengiaye C, Littleford J, Davies S, Thapar K, Kingdom J. Goal oriented general anesthesia for Cesarean section in a parturient with a large intracranial epidermoid cyst. *Can J Anaesth*. **2001**;48(9):884-9.
23. Van de Velde M, Teunkens A, Kuypers M, Dewinter T, Vandermeersch E. General anaesthesia with target controlled infusion of propofol for planned caesarean section: maternal and neonatal effects of a remifentanil-based technique. *Int J Obstet Anesth*. **2004**;13(3):153-8.
24. Scott C, Kaliaperumal C. Idiopathic intracranial hypertension and pregnancy: A comprehensive review of management. *Clin Neurol Neurosurg*. **2022**;217:107240.
25. Gragasin FS, Chiarella AB. Use of an Intrathecal Catheter for Analgesia, Anesthesia, and Therapy in an Obstetric Patient with Pseudotumor Cerebri Syndrome. *A A Case Rep*. **2016**;6(6):160-2.
26. Moore DM, Meela M, Kealy D, Crowley L, McMorrow R, O'Kelly B. An intrathecal catheter in a pregnant patient with idiopathic intracranial hypertension: analgesia, monitor and therapy? *Int J Obstet Anesth*. **2014**;23(2):175-8.
27. Palop R, Choed-Amphai E, Miller R. Epidural anesthesia for delivery complicated by benign intracranial hypertension. *Anesthesiology*. **1979**;50(2):159-60.
28. Bedson CR, Plaat F. Benign intracranial hypertension and anaesthesia for caesarean section. *Int J Obstet Anesth*. **1999**;8(4):288-90.
29. Pagani-Estévez GL, Chen JJ, Watson JC, Leavitt JA. Acute Vision Loss Secondary to Epidural Blood Patch: Terson Syndrome. *Reg Anesth Pain Med*. **2016**;41(2):164-8.
30. Aly EE, Lawther BK. Anaesthetic management of uncontrolled idiopathic intracranial hypertension during labour and delivery using an intrathecal catheter. *Anaesthesia*. **2007**;62(2):178-81.
31. Miller EC, Leffert L. Stroke in Pregnancy: A Focused Update. *Anesth Analg*. **2020**;130(4):1085-96.
32. Wang A, Saad AF. Hemorrhagic Stroke in Pregnancy. *Clin Obstet Gynecol*. **2023**;66(1):223-30.
33. Ellwood SJ, Mootz AA, Carabuena JM, Farber MK, Reale SC. Management of sporadic intracranial vascular malformations in pregnancy: a retrospective analysis. *Int J Obstet Anesth*. **2024**;58:103989.
34. von Knobelsdorff G, Paris A. Intracerebral hemorrhage after cesarean section under spinal anesthesia. Coincidence or causality? *Anaesthesist*. **2004**;53(1):41-4.
35. Eggert SM, Eggers KA. Subarachnoid haemorrhage following spinal anaesthesia in an obstetric patient. *Br J Anaesth*. **2001**;86(3):442-4.
36. Choi CK, Tyagaraj K. Combined spinal-epidural analgesia for laboring parturient with Arnold-Chiari type I malformation: a case report and a review of the literature. *Case Rep Anesthesiol*. **2013**;2013:512915.
37. Chantigian RC, Koehn MA, Ramin KD, Warner MA. Chiari I malformation in parturients. *J Clin Anesth*. **2002**;14(3):201-5.
38. Landau R, Giraud R, Delrue V, Kern C. Spinal anesthesia for cesarean delivery in a woman with a surgically corrected type I Arnold Chiari malformation. *Anesth Analg*. **2003**;97(1):253-5, table of contents.
39. Waters JFR, O'Neal MA, Pilato M, Waters S, Larkin JC, Waters JH. Management of Anesthesia and Delivery in Women with Chiari I Malformations. *Obstet Gynecol*. **2018**;132(5):1180-4.
40. Yamada S, Won DJ, Yamada SM, Hadden A, Siddiqi J. Adult tethered cord syndrome: relative to spinal cord length and filum thickness. *Neurol Res*. **2004**;26(7):732-4.
41. O'Neal MA. A Pregnant Woman with Spina Bifida: Need for a Multidisciplinary Labor Plan. *Front Med (Lausanne)*. **2017**;4:172.
42. Garvey GP, Wasade VS, Murphy KE, Balki M. Anesthetic and Obstetric Management of Syringomyelia during Labor and Delivery: A Case Series and Systematic Review. *Anesth Analg*. **2017**;125(3):913-24.
43. Hebl JR, Horlocker TT, Kopp SL, Schroeder DR. Neuraxial blockade in patients with preexisting spinal stenosis, lumbar disk disease, or prior spine surgery: efficacy and neurologic complications. *Anesth Analg*. **2010**;111(6):1511-9.
44. Moen V, Dahlgren N, Irestedt L. Severe neurological complications after central neuraxial blockades in Sweden 1990-1999. *Anesthesiology*. **2004**;101(4):950-9.
45. Bédard JM, Richardson MG, Wissler RN. Epidural anesthesia in a parturient with a lumboperitoneal shunt. *Anesthesiology*. **1999**;90(2):621-3.
46. Kaul B, Vallejo MC, Ramanathan S, Mandell GL, Krohner RG. Accidental spinal analgesia in the presence of a lumboperitoneal shunt in an obese parturient receiving enoxaparin therapy. *Anesth Analg*. **2002**;95(2):441-3, table of contents.
47. Metterlein T, Kuenzig H, Bele S, Brawanski A, Graf BM. Coma after spinal anaesthesia in a patient with an unknown intracerebral tumour. *Acta Anaesthesiol Scand*. **2010**;54(9):1149-51.
48. Alves S, Sousa N, Cardoso L, Alves J. Multidisciplinary management of idiopathic intracranial hypertension in pregnancy: case series and narrative review. *Braz J Anesthesiol*. **2022**;72(6):790-4.
49. Hönemann C, Moormann S, Hagemann O, Doll D. Spinal anesthesia for cesarean delivery in a patient with syringomyelia. *Int J Gynaecol Obstet*. **2014**;125(2):172-4.
50. Margarido C, Mikhael R, Salman A, Balki M. Epidural anesthesia for Cesarean delivery in a patient with post-traumatic cervical syringomyelia. *Can J Anaesth*. **2011**;58(8):764-8.

Challenge Journal of Perioperative Medicine

Case Report

Triple threat: Anesthetic approach to IVF twin gestation, pre-eclampsia and peripartum cardiomyopathy in caesarean section

Ranganath Laxman Channappagoudar [a,*], Chaitra Venkatesh Konappanavar [a], T. K. Darshini [a], Akanksha Priya [a]

[a] *S. Nijalingappa Medical College and H.S.K Hospital, Navanagar, Bagalkote, Karnataka, India*

ABSTRACT

Peripartum cardiomyopathy (PPCM) is a rare idiopathic condition frequently presenting with heart failure secondary to left ventricular systolic dysfunction towards the end of pregnancy or in the months following delivery. Can present as acute life-threatening pulmonary oedema in late pregnancy or early puerperium, its diagnosis is mainly by exclusion of other causes of cardiac dysfunction. Anaesthetic management of such cases poses a challenge; due to the increased risk of various perioperative complications. Morbidity is high due to the reduced physiological reserve in pregnancy. PPCM and severe pre-eclampsia can co-exist and their clinical presentation may overlap, making the diagnosis more difficult and often delayed, with potentially devastating consequences. We report the successful anaesthetic management of lower segment caesarean section in a patient with PPCM with preeclampsia of IVF twin gestation.

ARTICLE INFO

Article history:
Received – January 1, 2025
Revision requested – January 27, 2025
Revision received – February 10, 2025
Accepted – February 18, 2025

Keywords:
Peripartum cardiomyopathy
Heart failure
Left ventricular systolic dysfunction
General anaesthesia
Hypertensive disorders of pregnancy
Ejection fraction

Citation: Channappagoudar RL, Konappanavar CV, Darshini TK, Priya A. Triple threat: Anesthetic approach to IVF twin gestation, pre-eclampsia and peripartum cardiomyopathy in caesarean section. *Chall J Perioper Med*. **2025**; 3(1):21–25.

1. Introduction

Peripartum cardiomyopathy (PPCM) is a rare form of heart failure occurring late in pregnancy or shortly after delivery, characterized by acute heart failure without prior cardiac dysfunction. Its etiology remains unclear, potentially involving viral infections and hemodynamic stress [1,2]. Symptoms often overlap with other pregnancy complications, making diagnosis and management more difficult [3]. Key risk factors include advanced maternal age, multiple gestations, and pre-eclampsia [4,5]. Effective management necessitates a multidisciplinary approach to optimize maternal and fetal outcomes [6,7]. This case report details a 30-year-old primigravida with PPCM, illustrating the complexities in managing this condition during pregnancy and delivery.

2. Case Presentation

A 30-year-old primigravida at 31.3 weeks of gestation with a dichorionic-diamniotic (DCDA) twin pregnancy with (In Vitro Fertilization) IVF conception, developed gestational hypertension in the third trimester, which was well controlled with Tab Labetalol. The patient presented with complaints of growing fatigue, troubled breathing, and severe dyspnoea on minimal exertion.

* *Corresponding author*. E-mail address: drranganath53@gmail.com (R. L. Channappagoudar)
ISSN: 2980-292X / DOI: https://doi.org/10.20528/cjpm.2025.01.004

On examination, the patient exhibited a systolic murmur and bilateral basal crepitations with a blood pressure of 180/110 mmHg, alongside She had no prior history of hypertension, asthma or other co-morbidities and had not been on any medications before. Initial workup revealed non-specific ST-T wave changes on electrocardiogram (ECG) and echocardiographic findings indicative of peripartum cardiomyopathy (PPCM), including:

Left ventricular ejection fraction (LVEF): 35%, Left ventricular diastolic dysfunction: Grade 3, Dilated right ventricle and right atrium, Mild mitral regurgitation (MR).

She was started on medical therapy with Tab Labetalol (100 mg three times daily), Tab Furosemide (40 mg), and Tab Ecospirin (150 mg). Although she was discharged with medical management, she later presented with worsening symptoms: shortness of breath, orthopnea, chest pain, and peripheral oedema.

Physical examination at this time showed jugular venous distension, peripheral oedema, a loud S3 heart sound, a systolic murmur, and bilateral basal crepitations. Her oxygen saturation was 88% on room air and 92% on 12 liters of oxygen. Her respiratory rate was 31 breaths per minute, and arterial blood gas (ABG) analysis revealed respiratory acidosis.

Repeat echocardiography showed: Ejection fraction: 30-35%, Global hypokinesia, Moderate MR, Mild pericardial effusion, Moderate pleural effusion.

An urgent caesarean section was planned due to non-reassuring fetal heart rate. Preoperatively, her pulse rate was 112 beats per minute, with a non-invasive blood pressure (NIBP) of 130/80 mmHg. Informed consent was obtained after discussing the risks and prognosis with the patient and her family. The patient was wheeled into the operating theatre in a left lateral position and on continuous oxygen therapy. General anaesthesia was planned due to the emergency nature of the surgery, anticoagulation status, and severe left ventricular systolic impairment. Standard monitoring was initiated, including heart rate, NIBP and SpO2. An 18-gauge peripheral IV cannula was inserted, with the table tilted to left lateral position. Left radial artery was cannulated under local anaesthesia (LA). Central right internal jugular cannulation was also performed under LA. Rapid sequence intubation done with Inj Etomidate 20mg IV, Inj Fentanyl 75mcg IV. Endotracheal intubation was facilitated with Inj Atracurium (30 mg IV) and confirmed by auscultation and EtCO2 monitoring. Hemodynamic parameters stabilized with and the invasive arterial blood pressure (IABP) was 118/76 mmHg. Saline boluses of 30ml were administered to maintain adequate preload. Anaesthesia was maintained with isoflurane and oxygen. Saturation was kept between 97-99%. After the delivery of the twin babies, an infusion of oxytocin (20 units in 500 ml normal saline) was started. Both babies were intubated due to respiratory distress.

Postoperatively, patient was electively ventilated and transferred to the ICU on ventilatory support. Inj.Furosemide 40mg BD and Infusion Nitroglycerin infusion was titrated in doses of 0.5-8 microgram/kg/min to maintain stable hemodynamics which was gradually tapered off. She was successfully weaned off the ventilator and extubated 12hours later. Post-extubation, the patient was conscious, oriented, and maintaining SpO2 of 97%, NIBP was 110/70 mmHg. She was discharged to the ward on the 6th postoperative day with stable hemodynamics and was prescribed diuretics, and beta-blockers. Both the newborn were successfully weaned from ventilator and discharged after 40days.

3. Discussion

Peripartum cardiomyopathy (PPCM) presents a significant challenge in obstetric anaesthesia, requiring careful management to ensure the safety of both mother and child.

Echocardiography is essential for diagnosing PPCM, assessing left ventricular ejection fraction (LVEF), and ruling out other structural heart diseases. **A**pproximately 15% of PPCM cases have genetic variants similar to those in nonischemic dilated cardiomyopathy. Genetic testing is recommended in most cases.

PPCM is characterised by the onset of acute congestive heart failure without any demonstrable cause in the last trimester of pregnancy or within the first six months after delivery [1]. The diagnostic criteria include: (1) development of heart failure in the last month of pregnancy or within five months postpartum, (2) absence of pre-existing cardiac dysfunction, (3) absence of determinable cause of cardiomyopathy, and (4) left ventricular systolic dysfunction demonstrated by echocardiographic criteria [2].

The overlap between PPCM and severe pre-eclampsia symptoms can complicate timely diagnosis. The patient initially presented with gestational hypertension, which later progressed to symptoms suggestive of heart failure. This progression underscores the importance of maintaining a high index of suspicion for PPCM in pregnant women with cardiac symptoms, especially those with pre-existing hypertensive disorders [3]. The differential diagnosis between PPCM and other pregnancy-related cardiac conditions can be challenging, requiring comprehensive clinical evaluation [4].

In this case, the patient exhibited features such as chest pain, systolic murmurs, and dyspnoea, which suggested acute congestive heart failure. The echocardiographic findings of reduced ejection fraction (30-35%), global hypokinesia, and valvular regurgitation were key in establishing the diagnosis of PPCM [5]. The deterioration of the patient's condition despite initial medical management highlights the potential for rapid progression in PPCM cases, necessitating close monitoring and readiness for urgent intervention [6].

While the exact aetiology of PPCM remains elusive, various factors have been hypothesised, including viral, autoimmune, and hemodynamic stress of pregnancy [7]. Risk factors for PPCM include maternal age over 30 years, multiparity, eclampsia, and obesity [8]. Our patient had underlying risk factors such as advanced maternal age, pre-eclampsia, IVF conception, and twin gestation, along with clinical features consistent with PPCM.

3.1. Medical management

Treatment aligns with heart failure protocols, emphasizing:

- Beta-Blockers: Safe during pregnancy and breastfeeding.
- Hydralazine and IsosorbideDinitrate: Considered safe during pregnancy.
- Diuretics: Use cautiously to avoid dehydration and electrolyte imbalances.
- ACE Inhibitors/ARBs and Mineralocorticoid Receptor Antagonists are generally avoided during pregnancy due to potential teratogenic effects

3.2. Anaesthetic management

The choice of anaesthesia for caesarean delivery in PPCM patients is crucial and should aim to optimise preload and afterload while maintaining myocardial contractility [9]. NeuraxialAnesthesia:generally the preferred choice for cesarean delivery. Provides sympathetic blockade, reducing afterload and preload, which can benefit patients with heart failure. General Anesthesia indicated in cases of cardiopulmonary decompensation requiring intubation or if there are contraindications to neuraxialanesthesia, such as ongoing anticoagulation therapy, severe thrombocytopenia, or the patient's refusal of neuraxialanesthesia. In this case, general anaesthesia was chosen due to the urgent nature of the surgery and the severity of PPCM [10]. The use of invasive haemodynamic monitoring allowed for precise control of the patient's cardiovascular status throughout the procedure [11]. The careful titration of anaesthetic agents (Fentanyl and Etomidate) and the use of low-dose isoflurane for maintenance demonstrate the balance required between providing adequate anaesthesia and avoiding myocardial depression. The goal is to maintain adequate systemic perfusion without overly increasing afterload, which could further compromise cardiac function. The use of small fluid boluses (30 ml saline) to maintain preload demonstrates the cautious approach to fluid management required in PPCM patients.

Table 1. Hemodynamic changes peripartum and plans for mitigation [12].

Hemodynamic issue	Possible consequences	Plan
↑ Catecholamines (attributable to pain and anxiety)	↑ Tachycardia and arrhythmias	Avoid sudden alterations in heart rate and rhythm with neuraxialanesthesia
↓ Systemic vascular resistance (attributable to neuraxialanesthesia, pregnancy hormones, and hemorrhage)	↓ Coronary perfusion from decreased aortic diastolic pressure and increased LV end-diastolic pressure	Control sudden decreases in afterload (systemic vascular resistance) with appropriate use of vasopressorsControl sudden decreases in afterload (systemic vascular resistance) with appropriate use of vasopressors
↑ Cardiac output must increase through labor and delivery to accommodate the expected autotransfusion (preload changes	↑ Heart failure	Support the myocardium with inotropic medications or VA ECMO Diuresis as needed
↑ Pulmonary blood flow	↑ Pulmonary pressure if pulmonary vascular resistance cannot decrease↑ Pulmonary pressure if pulmonary vascular resistance cannot decrease	Provide pulmonary vasodilators Control sudden changes in blood volume with diuresis
↓ Oncotic pressure	↑ Pulmonary edema	Diuresis as needed

3.3. Postoperative care

The decision to keep the patient intubated and transfer to the ICU reflects the high-risk nature of PPCM and the need for close monitoring in the immediate postoperative period. The gradual weaning of ventilatory support allowed for a controlled transition to spontaneous breathing and haemodynamic stability.

3.4. Long-term management

The discharge medications (diuretics and beta-blockers) are consistent with current guidelines for managing heart failure in PPCM. However, the management of PPCM extends beyond the immediate perioperative period. Ongoing cardiology follow-up is crucial, as some may experience improvement in cardiac function over time, while others may require long-term management [13].

3.5. Multidisciplinary approach

The successful management of this case required coordination between obstetricians, anaesthetists, cardiologists, and critical care specialists. This multidisciplinary approach is essential in managing the complex needs of PPCM patients and optimising outcomes for both mother and baby.

While this case had a favourable outcome, it raises important questions about the management of future pregnancies in women with a history of PPCM. Current evidence suggests that subsequent pregnancies carry a significant risk of PPCM recurrence and potential worsening of cardiac function. Counselling about these risks and close monitoring in any future pregnancies would be crucial.

Extracorporeal Membrane Oxygenation (ECMO) is a critical last-line support for acute respiratory failure, ventricular failure, or cardiovascular decompensation.

Early ECMO intervention during maternal cardiac arrest has proven lifesaving, with success rates of 87.7% for ECMO-assisted resuscitations compared to 58.9% without it. ECMO use in pregnancy most commonly addresses conditions such as adult respiratory distress syndrome, cardiac failure, pulmonary hypertension, and amniotic fluid embolism. Early deployment of an ECMO team, along with pre-insertion of placeholder sheaths for rapid cannulation, is essential to ensure prompt intervention when necessary [12].

Table 2. Long-term prognosis after peripartum cardiomyopathy [14,15].

1. Recovery of Heart Function:
Many women with PPCM experience partial or complete recovery of heart function over time, particularly with prompt diagnosis and appropriate management. Some may experience persistent heart failure or reduced ejection fraction.
2. Recurrence Risk in Future Pregnancies:
Risk of Recurrence: The risk of recurrence in future pregnancies varies but is generally estimated to be between 20-30%. This risk is higher if the individual had a poor recovery from the initial episode, if they had a low ejection fraction (less than 35%), or if they were diagnosed with severe PPCM.
Managing Recurrence Risk: Women with a history of PPCM should be closely monitored during any future pregnancy. Multidisciplinary care involving a cardiologist, obstetrician, and other specialists is essential. Early detection of recurrence is key to preventing complications.
3. Impact on Future Pregnancies:
Women who have fully recovered or have only mild residual heart damage may be able to safely have additional pregnancies, though the risks need to be carefully weighed.
For women with persistent heart dysfunction, further pregnancies could be associated with an increased risk of worsening heart failure, preterm labor, and other complications like gestational hypertension.
4. Management in Future Pregnancies:
A careful assessment of heart function before conception is essential. Pregnancy could place increased stress on the heart, and women with significant left ventricular dysfunction may be advised to avoid pregnancy.
Medications: Some medications used in treating PPCM, such as ACE inhibitors and certain diuretics, are contraindicated in pregnancy. These may need to be discontinued before conception.

4. Conclusions

This case report illustrates the successful management of a complex PPCM case, emphasizing the importance of early recognition, appropriate anaesthetic technique, and multidisciplinary care in achieving favourable outcomes. The management of PPCM requires a delicate balance between maintaining haemodynamic stability and providing adequate anaesthesia, all while preparing for potential complications.

Acknowledgements
None declared.

Funding
The authors received no financial support for the research, authorship, and/or publication of this manuscript.

Conflict of Interest
The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

Author Contributions
All of the authors made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; were involved in drafting the manuscript or revising it critically for important intellectual content; and gave final approval of the version to be published.

Data Availability
The datasets created and/or analyzed during the current study are not publicly available, but are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate
Not applicable.

REFERENCES

1. Sliwa K, Hilfiker-Kleiner D, Petrie MC, Mebazaa A, Pieske B, Buchmann E, Regitz-Zagrosek V, Schaufelberger M, Tavazzi L, van Veldhuisen DJ, Watkins H. Current state of knowledge on aetiology, diagnosis, management, and therapy of peripartum cardiomyopathy: a position statement from the Heart Failure Association of the European Society of Cardiology Working Group on peripartum cardiomyopathy. *Eur J Heart Fail*. **2010**;12(8):767-78.
2. Pearson GD, Veille JC, Rahimtoola S, Hsia J, Oakley CM, Hosenpud JD, Ansari A, Baughman KL. Peripartum cardiomyopathy: National Heart, Lung, and Blood Institute and Office of Rare Diseases (National Institutes of Health) workshop recommendations and review. *JAMA*. **2000**;283(9):1183-8.

3. Elkayam U. Clinical characteristics of peripartum cardiomyopathy in the United States: diagnosis, prognosis, and management. *J Am Coll Cardiol*. **2011**;58(7):659-70.
4. Hilfiker-Kleiner D, Haghikia A, Nonhoff J, Bauersachs J. Peripartum cardiomyopathy: current management and future perspectives. *Eur Heart J*. **2015**;36(18):1090-7.
5. Lang RM, Badano LP, Mor-Avi V, Afilalo J, Armstrong A, Ernande L, Flachskampf FA, Foster E, Goldstein SA, Kuznetsova T, Lancellotti P. Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. *Eur Heart J Cardiovasc Imaging*. **2015**;16(3):233-71.
6. Arany Z, Elkayam U. Peripartum cardiomyopathy. *Circulation*. **2016**;133(14):1397-409.
7. Elkayam U, Akhter MW, Singh H, Khan S, Bitar F, Hameed A, Shotan A. Pregnancy-associated cardiomyopathy: clinical characteristics and a comparison between early and late presentation. *Circulation*. **2005**;111(16):2050-5.
8. Ramachandran R, Rewari V, Trikha A. Anaesthetic management of patients with peripartum cardiomyopathy. *J Obstet Anaesth Crit Care*. **2011**;1(1):5-12.
9. Dennis AT, Solnordal CB. Acute pulmonary oedema in pregnant women. *Anaesthesia*. **2012**;67(6):646-59.
10. Honigberg MC, Givertz MM. Peripartum cardiomyopathy. *BMJ*. **2019**;364.
11. Elkayam U, Tummala PP, Rao K, Akhter MW, Karaalp IS, Wani OR, Hameed A, Gviazda I, Shotan A. Maternal and fetal outcomes of subsequent pregnancies in women with peripartum cardiomyopathy. *N Engl J Med*. **2001**;344(21):1567-71.
12. Meng ML, Arendt KW, Banayan JM, et al. Anesthetic care of the pregnant patient with cardiovascular disease: a scientific statement from the American Heart Association. *Circulation*. **2023**;147(11):e000-e000.
13. Sliwa K, Hilfiker-Kleiner D, Mebazaa A, Petrie MC, Maggioni AP, Regitz-Zagrosek V, Schaufelberger M, Tavazzi L, van Veldhuisen DJ, Roos-Hesslink JW, Shah AJ. EURObservational Research Programme: a worldwide registry on peripartum cardiomyopathy (PPCM) in conjunction with the Heart Failure Association of the European Society of Cardiology Working Group on PPCM. *Eur J Heart Fail*. **2014**;16(5):583-91.
14. Mital S, Phelan J. Preeclampsia and Peripartum Cardiomyopathy. *J Cardiovasc Med*. **2019**;20(9):701-8.
15. Liu D, Gong J, Zhi Q, et al. Long-term outcomes of women with peripartum cardiomyopathy. *J Am Coll Cardiol*. **2020**;75(1):17-26.

Challenge Journal of Perioperative Medicine

Case Report

Unexpected venous anomaly around the brachial plexus during supraclavicular block: A case report

Kübra Yazici [a,*]

[a] *Department of Anesthesiology and Reanimation, Aliağa State Hospital, Aliağa, İzmir, Türkiye*

ABSTRACT

Anatomical variations in the supraclavicular region can greatly affect the success and safety of regional anesthesia techniques, particularly supraclavicular brachial plexus blocks. Identifying these variations is essential to minimize risks. This case involves a 32-year-old male patient with a distal humeral fracture, where an ultrasound-guided supraclavicular block revealed an unusual venous structure encircling the brachial plexus. This atypical vein could pose significant risks, including vascular injury, local anesthetic toxicity, and even cardiac arrest, depending on the anesthetic uBased on its anatomical location and Doppler features, the vein was hypothesized to originate from the subclavian or external jugular vein. This finding underscores the critical importance of thorough ultrasound evaluation and real-time guidance during the procedure to avoid complications. Recognizing such anatomical anomalies is vital to ensuring patient safety, and the integration of ultrasound into routine regional anesthesia practice enhances both precision and effectiveness.

ARTICLE INFO

Article history:
Received – December 29, 2024
Revision requested – January 18, 2025
Revision received – February 15, 2025
Accepted – February 25, 2025

Keywords:
Brachial plexus
Peripheral block
Anatomical variation
Ultrasound

Citation: Yazici K. Unexpected venous anomaly around the brachial plexus during supraclavicular block: A case report. *Chall J Perioper Med*. **2025**; 3(1):26–29.

1. Introduction

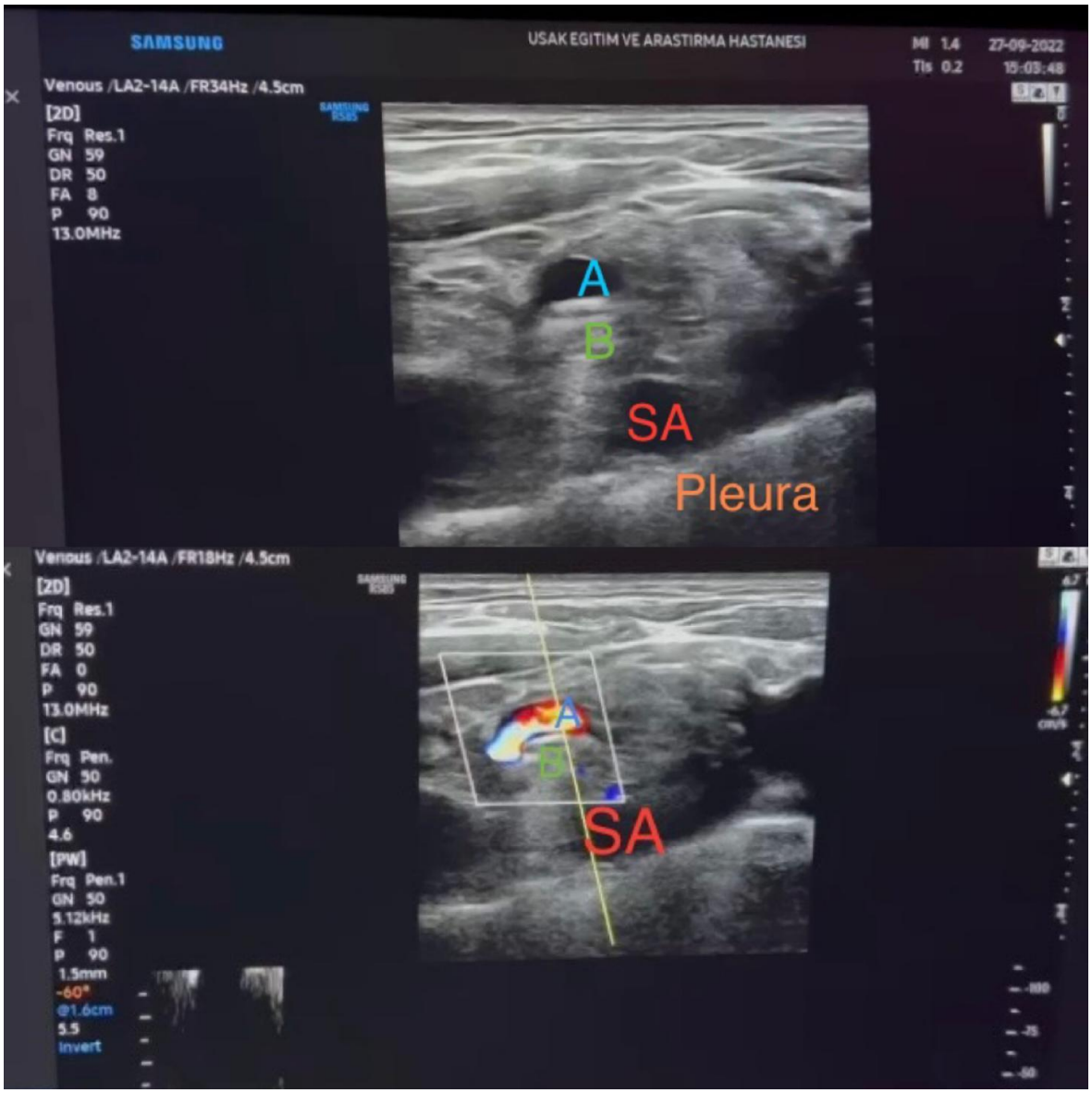
Peripheral nerve blocks, an essential component of regional anesthesia, have become increasingly popular with the widespread use of ultrasound [1–3]. The supraclavicular block is an excellent technique for anesthesia and analgesia of the upper extremity, especially with the widespread use of ultrasound. The use of ultrasound in peripheral nerve blocks has not only improved the understanding of anatomy but also allowed the identification of anatomical variations. As a result, it has positively contributed to the benefit side of the risk-benefit curve in regional anesthesia and led to the resurgence of certain peripheral block techniques.

The supraclavicular block involves blocking the brachial plexus at the supraclavicular fossa. After its first description in 1912 [4], its use significantly declined due to catastrophic complications such as pneumothorax, hemothorax, local anesthetic toxicity, and phrenic nerve paralysis [5,6]. These complications arise from the critical anatomical relationships of the brachial plexus in the supraclavicular fossa with structures such as the subclavian artery, subclavian vein, and pleura. In the supraclavicular fossa, the brachial plexus lies within the connective tissue, with the middle scalene muscle laterally and the subclavian artery anteromedially. Below lie the apex of the lung, the pleura, and the first rib. The advancement of ultrasound-guided regional anesthesia techniques has led to the renewed popularity of the supraclavicular block. Additionally, following the widespread use of ultrasound, many anatomical variation reports have also been published [7,8]. From this perspective, ultrasound may contribute to patient safety by reducing complications, as it reveals anatomical diversity during the procedure. This case report aims to discuss the identification of an anatomical variation recognized during a supraclavicular block and its safe application.

* *Corresponding author*. E-mail address: drkubra25@gmail.com (K. Yazici)
ISSN: 2980-292X / DOI: https://doi.org/10.20528/cjpm.2025.01.005

2. Case Presentation

A 32-year-old male patient presented with a distal humeral fracture following a same-level fall. No significant medical history, including surgeries, chronic illnesses, or allergies, was noted. Physical examination and diagnostic tests, including ECG, chest X-ray, and laboratory investigations, revealed no abnormalities. Both peripheral nerve block and general anesthesia were explained to the patient. Based on patient preference, a supraclavicular block was planned. Written informed consent was obtained. According to the surgical plan, the patient was taken to the operating room and then to the block room for the supraclavicular block. Blood pressure and oxygen saturation were monitored, and 1 mg of midazolam with 50 mcg of fentanyl was administered intravenously. The ultrasound device was positioned on the patient's left side, and the right supraclavicular region was scanned using a linear ultrasound probe. The prob is placed into the supraclavicular fossa, paralel to the clavicula. The subclavian artery, which is the primary anatomical landmark for the block, and brachial plexus were visualised. A vascular structure encircling the brachial plexus was observed (Fig. 1-a), and venous flow within this structure was confirmed using Doppler ultrasound (Fig. 1-b). To ensure safety and avoid vascular puncture, a real-time ultrasound-guided in-plane technique was used.



A: Unexpected vascular anomaly; B: Brachial plexus; SA: Subclavian artery.

Fig. 1. (a) A vascular structure encircling the brachial plexus; (b) Venous flow within this structure.

A linear ultrasound probe (LA2-14A; Samsung HM70 EVO) visualized the brachial plexus in the postero-supero-lateral aspect of the subclavian vein. An abnormal vascular structure, likely originating from the external jugular or subclavian vein, entered the imaging field. In the classical supraclavicular approach, the needle was advanced to the 'corner pocket' (first rib to the anterior aspect of the plexus), then redirected to the superficial

plexus portion. Local anesthetic (LA) was injected at both sites. To avoid puncturing the vascular structure, the safest point was identified as the corner pocket. Doppler confirmed the injection site, and a 22G 50 mm needle (Braun Stimuplex Ultra) was used. A mixture of 20 mL LA (10 mL 0.05% bupivacaine + 10 mL 2% lidocaine) with 100 mcg adrenaline was injected at the 9 o'clock position relative to the subclavian vein. Negative aspiration preceded every 3 mL injection, and no pressure was applied with the probe.The procedure was completed without complications. Approximately 30 minutes post-injection, sensory and motor blockade of the musculocutaneous, median, radial, and ulnar nerves was evaluated using a 3-point scale (0: No blockage, 1: Analgesia, 2: Anesthesia). The patient was transferred to the operating room, where standard monitoring and 1 mg of midazolam were administered. The 90-minute surgical procedure concluded without the need for additional analgesia or sedation. No postoperative complications were observed. Although a CT angiography was planned to determine the vascular structure's origin, the patient declined.

3. Discussion

Peripheral nerve blocks, a cornerstone of regional anesthesia, have gained popularity with the widespread use of ultrasound. The supraclavicular approach, commonly used for upper extremity surgeries, has seen a resurgence due to ultrasound guidance, which enhances safety and efficacy. Despite its benefits, the supraclavicular region's complex anatomy—close to vascular structures, the phrenic nerve, recurrent laryngeal nerve, and pleura—poses risks [9]. Serious complications such as delayed pneumothorax, hemothorax, and even cerebral edema have been reported in the literature following supraclavicular block [5,6,10]. However, with the widespread use of ultrasound, not only has normal anatomy become more visible, but anatomical variations can now also be visualized in real time. This allows us to anticipate and mitigate not only the natural complications associated with the block itself but also those arising from anatomical variations during the procedure. Ultrasound improves block success and minimizes complications by visualizing anatomical variations preoperatively and intraoperatively [11]. In our case, ultrasound revealed an unexpected vascular anomaly, potentially leading to catastrophic outcomes, such as cardiac arrest, during LA injection if undetected. Such variations are common in the supraclavicular region [12–14]. Ultrasound enabled a safe and effective block, highlighting its critical role in this anatomically complex area. Therefore, in our case, despite the identification of an anatomical variation during the pre-procedural ultrasound assessment, the supraclavicular technique was not abandoned. Additionally, based on our clinical experience and the existing literature, the supraclavicular block provides superior anesthesia compared to infraclavicular techniques for mid and distal humerus surgeries [15]. However, there are also studies in the literature that find the infraclavicular block to be as effective as the supraclavicular block [16].

4. Conclusions

This case highlights the critical role of ultrasound guidance in ensuring safe and effective supraclavicular brachial plexus blocks. The identification of an unexpected vascular anomaly emphasizes the importance of thorough ultrasound evaluation to prevent life-threatening complications, such as vascular injury or anesthetic toxicity. Given the frequent anatomical variations in this region, careful planning and real-time imaging are essential for successful outcomes. Integrating ultrasound into routine practice enhances patient safety and enables a tailored approach to anatomical variability.

Acknowledgements
None declared.

Funding
The author received no financial support for the research, authorship, and/or publication of this manuscript.

Conflict of Interest
The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

Data Availability
The datasets created and/or analyzed during the current study are not publicly available, but are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate
Not applicable.

REFERENCES

1. Sites BD, Spence BC, Gallagher J, Beach ML, Antonakakis JG, Sites VR, Hartman GS. Regional anesthesia meets ultrasound: a specialty in transition. *Acta Anaesthesiol Scand*. **2008**;52(4):456-66.
2. Marhofer P, Harrop-Griffiths W, Kettner SC, Kirchmair L. Fifteen years of ultrasound guidance in regional anaesthesia: Part 1. *Br J Anaesth*. **2010**;104(5):538-46.
3. Griffin J, Nicholls B. Ultrasound in regional anaesthesia. *Anaesthesia*. **2010**;65 Suppl 1:1-12.
4. Kulenkampff D. Die Anästhesierung des Plexus brachialis. *DMW-Deutsche Medizinische Wochenschrift*. **1912**;38(40):1878-80.
5. Kumari A, Gupta R, Bhardwaj A, Madan D. Delayed pneumothorax after supraclavicular block. *J Anaesthesiol Clin Pharmacol*. **2011**;27(1):121-2.
6. Singh SK, Katyal S, Kumar A, Kumar P. Massive hemothorax: A rare complication after supraclavicular brachial plexus block. *Anesth Essays Res*. **2014**;8(3):410-2.
7. Kinjo S, Frankel A. Failure of supraclavicular block under ultrasound guidance: clinical relevance of anatomical variation of cervical vessels. *J Anesth*. **2012**;26(1):100-2.
8. Lavallée C, Ayoub C, Mansour A, Lambert J, Lebon JS, Lalu MM, Denault A. Subclavian and axillary vessel anatomy: a prospective observational ultrasound study. *Can J Anaesth*. **2018**;65(4):350-9.
9. Sadowski M, Tułaza B, Lysenko L. Renaissance of supraclavicular brachial plexus block. *Anaesthesiol Intensive Ther*. **2014**;46(1):37-41.
10. Eskin MB, Ceylan A. Brain edema after ultrasound-guided supraclavicular block. *Ann Ital Chir*. **2020**;9.
11. Delaunay L, Plantet F, Jochum D. [Ultrasound and regional anaesthesia]. *Ann Fr Anesth Reanim*. **2009**;28(2):140-60.

12. Go JY, Han DJ, Kim J, Yoon SP. A supraclavicular cephalic vein drained into the subclavian vein. *Surg Radiol Anat*. **2017**;39(12):1413-5.
13. Paraskevas GK, Raikos A, Chouliaras K, Papaziogas B. Variable anatomical relationship of phrenic nerve and subclavian vein: clinical implication for subclavian vein catheterization. *Br J Anaesth*. **2011**;106(3):348-51.
14. Turbendian HK, Mesher A, Mitchell MB. Supraclavicular Translocation of Aberrant Left Subclavian Artery for Vascular Ring Division and Resection of Kommerell's Diverticulum. *World J Pediatr Congenit Heart Surg*. **2020**;11(1):108-9.
15. Mian A, Chaudhry I, Huang R, Rizk E, Tubbs RS, Loukas M. Brachial plexus anesthesia: A review of the relevant anatomy, complications, and anatomical variations. *Clin Anat*. **2014**;27(2):210-21.
16. Zhang G, Hou X, Wang H, Han C, Fan D. Infraclavicular versus supraclavicular nerve block for upper limb surgeries: A meta-analysis. *Medicine (Baltimore)*. **2024**;103(43):e40152.

Challenge Journal of Perioperative Medicine

Letter to the Editor

Left colon volvulus following sigmoidectomy

Sabri Selcuk Atamanalp [a,*]

[a] *Department of General Surgery, Atatürk University School of Medicine, Erzurum, Türkiye*

ARTICLE INFO

Article history:
Received – January 13, 2025
Accepted – February 10, 2025

Keywords:
Sigmoid volvulus
Neo left colon volvulus
Intestinal obstruction
Sigmoidectomy

Citation: Atamanalp SS. Left colon volvulus following sigmoidectomy. *Chall J Perioper Med*. **2025**; 3(1):30–31.

Dear Editors,

Sigmoid volvulus is the torsion of the sigmoid colon resulting in a closed-loop intestinal obstruction [1]. Although sigmoid volvulus is the most common type of colonic obstruction with an incidence of 1.67 per 100,000 person-year in the United States, it is more common in Turkey, particularly in Eastern Anatolia with an incidence of 4.2 patients per 100,000 persons per year [2]. Sigmoid volvulus is a relatively well-defined clinical entity with its diagnostic, therapeutic, and prognostic features [3]. However, a semi-mystical clinical description in association with sigmoid volvulus, neo left colon volvulus, gained wide currency in recent years [4].

Due to the easy and early diagnosis of colorectal malignancies as well as sigmoid volvulus under auspices of flexible endoscopes and developed radiological techniques, sigmoidectomy via open or preferably laparoscopic surgery increased in number in recent times. It is clear that, the de-peritonization of the descending colon or even the resection of the left flexura is frequently required for a tension-free anastomosis to restore the intestinal continuity following sigmoidectomy. In the end, the descending colon becomes like an intraperitoneal vessel instead of its original anatomical position in retroperitoneal area. Most practitioners currently renames this new anatomical stricture as 'neo left colon', while some others traditionally prefer the 'descending colon' term as the previous description. In the end, no matter what is its name, the new bowel is under the risk of volvulus [4,5].

Sigmoid volvulus is not a mystery for most practitioners due to its relatively high incidence. However, following sigmoidectomy for colorectal malignancies or sigmoid volvulus, a new or repetitive bowel volvulus, neo left colon volvulus or metachronous descending colon volvulus, may come a revelation to some inexperienced practitioners. To prevent or reduce the poor prognosis arising from late diagnosis, the description of the new clinical entity becomes crucial. The most important detail is the presence of a previous left colon surgery in the medical history of such patients. Abdominal pain, distention, and obstipation are the main symptom and signs. Although plain abdominal X-ray radiographs causes a suspicion of intestinal obstruction by demonstrating air-fluid levels, the current diagnostic procedure is computed tomography with mesenteric whirl sign in addition to X-ray findings. Endoscopy, preferably flexible procedure is both diagnostic by demonstrating a spiral obstruction line in the bowel and therapeutic by allowing for decompression in uncomplicated patients. In cases with peritoneal irritation findings, unsuccessful endoscopic detorsion, or un-definitive diagnosis require emergency surgery including resection or fixation of the new colon. To prevent or reduce a recurrence risk, operative or endoscopic percutaneous colopexy may be used [6,7].

I think that, to be on alert for neo left colon volvulus or metachronous descending colon volvulus in patients with intestinal obstruction symptoms and signs will be beneficial in cases with previous medical history of left colon surgery.

* *Corresponding author*. E-mail address: ssa@atauni.edu.tr (S. S. Atamanalp)
ISSN: 2980-292X / DOI: https://doi.org/10.20528/cjpm.2025.01.006

Acknowledgements

None declared.

Funding

The author received no financial support for the research, authorship, and/or publication of this manuscript.

Conflict of Interest

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this manuscript.

Data Availability

The datasets created and/or analyzed during the current study are not publicly available, but are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

Not applicable.

REFERENCES

1. Brown J, Dick L, Watson A. Volvulus of the gastrointestinal tract. *Br J Hosp Med*. **2024**;85:1-9.
2. Atamanalp SS, Disci E, Peksoz R. Sigmoid volvulus and concomitant clinical entities. *Formos J Surg*. **2024**;57:87-92.
3. Atamanalp SS, Disci E, Peksoz R, Atamanalp RS, Tatar Atamanalp S. Management of sigmoid volvulus: A literature review. *Ibnosina Med J*. **2024**;16:5-9.
4. Huynh R, Reece M, Mansouri D, Nguyen TM, Keshava A. Laparoscopic colopexy for neo-left colonic volvulus 10 years after anterior resection. *J Surg Case Rep*. **2020**;12:1-3.
5. Kebede MA, Mohammed SM, Numaro YK, Mesfine YY, Worku AB, Birhanu AM. Metachronous volvulus of the descending colon after resection of the sigmoid volvulus: a case report. *Int J Surg Case Rep*. **2024**;123:110212.
6. Amare AG, Workneh GA, Tassaw MT, Kebede MM, Tegegne MA, Negussie MA. Metachronous descending colon volvulus after sigmoidectomy: a case report. *J Surg Case Rep*. **2025**;1:827.
7. Moritz C, Scheiwe C, Malgras B. Colonic volvulus after laparoscopic left colectomy. *J Visc Surg*. **2020**;157:493-4.