

Effect of ropivacaine combined with sufentanil epidural anesthesia in abdominal surgery

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Abstract: To explore and analyze the effect of ropivacaine plus sufentanil for epidural anesthesia during abdominal surgery, a total of 120 patients who underwent abdominal surgery at our institution between May 2019 and November 2020 were recruited and randomly assigned at a 1:1 ratio to receive either ropivacaine alone for epidural anesthesia (control group) or ropivacaine plus sufentanil (observation group). The total anesthesia effect in the observation group was significantly higher than that in the control group (96.66% vs 78.33%) ($P<0.05$). The combined anesthesia resulted in significantly lower visual analogue scale (VAS) scores (1.51 ± 0.84 , 1.63 ± 0.56 , 1.69 ± 0.63 , 1.54 ± 0.42) in patients at 4h, 8h, 16h, and 24h postoperatively versus ropivacaine alone (2.35 ± 0.88 , 2.49 ± 0.69 , 2.47 ± 0.78 , 2.39 ± 0.58) ($P<0.05$). The Ramsay sedation score (RSS) scores (1.98 ± 0.81 , 2.44 ± 0.62 , 2.18 ± 0.62 , 2.51 ± 0.37) of the observation group at 4h, 8h, 16h, and 24h after operation were significantly lower than those of the control group (1.42 ± 0.52 , 1.73 ± 0.71 , 1.47 ± 0.66 , 1.68 ± 0.62) ($P<0.05$). Patients receiving ropivacaine plus sufentanil were associated with a lower incidence of adverse reactions than those given ropivacaine only (5.00% vs 30.00%) ($P<0.05$). In abdominal surgery, ropivacaine plus sufentanil epidural anesthesia resulted in reduced postoperative pain, enhanced sedative effects, and a lower risk of adverse reactions versus ropivacaine alone.

Keywords: Ropivacaine, sufentanil, epidural anesthesia, abdominal surgery.

INTRODUCTION

Abdominal surgery for intra-abdominal lesions mainly includes gastrointestinal appendix, liver and gallbladder, kidney bladder, and female uterine appendages in the abdominal cavity. External abdominal surgery is the foundation of other surgical specialties and is a major component of general surgery (Martin-Flores *et al.*, 2019). In recent years, with the rapid development of diagnostic and therapeutic techniques, surgical treatment technology in China has received substantial advancement. Epidural anesthesia, also known as epidural block, is a commonly used anesthesia method in abdominal surgery, in which local anesthetic is injected into the epidural space to block the spinal nerve root and temporarily paralyze the innervated area. In surgical anesthesia, co-administration of anesthetic drugs is commonly adopted given the inconsistent anesthetic outcomes of different drugs. Drugs used for epidural anesthesia are mostly characterized by strong dispersion and penetration, low toxicity, rapid onset, and long maintenance, such as lidocaine, ropivacaine, and Bupivacaine (Homma *et al.*, 2022; López Álvarez *et al.*, 2022). In recent years, sufentanil compounded with ropivacaine lumbar anesthesia has been heavily investigated in patients undergoing cesarean section and labor analgesia, but its use in abdominal surgery has been sparsely studied (Chen *et al.*, 2020).

Ropivacaine is a new long-acting local anesthetic with the chemical name (-)-(S)-N-(2,6-dimethylphenyl)-1-n-propyl Piperidine-2-carboxamide (S)-N-(2,6-dimethylphenyl)-1-propyl-2-piperidinecarboxamide (Viderman *et al.*, 2021), and is mainly used for surgical block, epidural anesthesia and post-epidural or labor analgesia, with well-recognized effects on central, cardiovascular, neurotoxicity, and dissociation of sensory and motor nerve blocks (Wang *et al.*, 2022). In clinical trials, ropivacaine plus fentanyl for epidural anesthesia is associated with unsatisfactory outcomes. Moreover, the long-term use of fentanyl results in drug accumulation in vivo and adverse events such as nausea, vomiting, and drowsiness (Viderman *et al.*, 2021).

Sufentanil is a new synthetic opioid that mainly acts on μ opioid receptors, with lipophilicity twice that of fentanyl, is easy to pass through the blood-brain barrier, and yields a higher protein binding rate versus fentanyl, leading to a greater analgesic intensity and longer duration of action (Li *et al.*, 2020). In clinical practice, sufentanil is mostly employed as the principal agent for intravenous compound anesthesia or supplement anesthesia other than severe pain management. Sufentanil is a phenylpiperidine derivative with a comparable structure and function to fentanyl, and its analgesic impact is roughly 5-10 times stronger, with a quicker start of action, recovery of anesthesia, and breathing suppression (Zhang *et al.*, 2023).

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Poor intraoperative anesthesia may result in the abortion of surgical treatment due to intolerable pain. In recent years, epidural anesthesia and subarachnoid block are gradually introduced in laminectomy (Simmons *et al.*, 2019). Compared with subarachnoid block, epidural anesthesia is relatively cumbersome to operate, with prolonged induction time of anesthesia and onset time, higher dose of drugs, and a higher incidence of incomplete block and postoperative complications. Satisfactory analgesic effects of low concentration ropivacaine lumbar anesthesia have been reported in previous research, but further optimization is required to explore the effective concentration and dose for analgesic effects in abdominal surgery without compromising postoperative activity (Zhang *et al.*, 2023). Thus, the current study, therefore, explored the effect of ropivacaine combined with sufentanil epidural anesthesia in abdominal surgery.

MATERIALS AND METHODS

Study population

A total of 120 patients who underwent abdominal surgery in our hospital from May 2019 to November 2020 were recruited and randomized into two groups at a ratio of 1:1. There were 34 males and 26 females in the control group, aged 28-66 (39.23 ± 5.21) years, with a weight of 44-80 (59.84 ± 10.21) kg; there were 41 cases of American Society of Anesthesiologists (ASA) I grade and 19 cases of ASA II grade. In the observation group, there were 31 males and 29 females, aged 25-69 (40.21 ± 5.98) years old, with a weight of 45-82 (60.03 ± 9.98) kg; there were 39 cases of ASA I and 21 of ASA II. The patient characteristics of the two groups of patients were comparable (table 1).

The randomization was carried out using an online web-based randomization tool (freely available at <http://www.randomizer.org/>). For concealment of allocation, the randomization procedure and assignment were managed by an independent research assistant who was not involved in the screening or evaluation of the participants.

The original sample size calculation estimated that 60 patients in each group would be needed to detect a 3-point difference between groups in a 2-sided significance test with a power of 0.8 and an alpha error level of 0.05.

The trial was conducted according to Good Clinical Practice guidelines developed by the International Council for Harmonisation and in compliance with the trial protocol. The protocol was approved by the institutional review boards or independent ethics committees at each site. All patients provided written informed consent per the Declaration of Helsinki principles. An independent data monitoring committee

monitored safety and efficacy data. Ethics number: LI-LP20190405.

Inclusion and exclusion criteria

Inclusion criteria

(1) patients who received abdominal surgery in our hospital; (2) without a history of long-term use of analgesics and sedatives; (3) All patients and their families were aware of the study and signed the consent form voluntarily. (4) without serious cardiovascular, respiratory and neurological diseases; (5) patients with hypertension and diabetes mellitus had their blood pressure and blood glucose controlled according to routine preoperative preparations (blood pressure $<160/100$ mmHg; preoperative fasting blood glucose <11.1 mmol/L). (6) with hemoglobin >10 g/dL. (7) without contraindications to intrathecal anesthesia.

Exclusion criteria

(1) with heart, lung and nervous system diseases; (2) with coagulation dysfunction; (3) with related contraindications. (4) patients who refused to consent to intrathecal anesthesia or did not sign the informed consent form; (5) with severe cardiopulmonary insufficiency, central nervous system disease, spinal cord and peripheral nerve root lesions, history of spinal cord trauma or surgery, sepsis, shock, and fever; (6) with infection at the puncture site, coagulation disorders, history of drug abuse, history of allergy to local anesthetics, mental disorders, and poor compliance.

Methods

After entering the operating room, the two groups of patients were given 0.5mg of atropine and 0.1g of phenobarbital sodium via intramuscular injection 30 minutes before anesthesia. After the establishment of venous access, compound sodium lactate 8-10ml/kg was administered to monitor BP, HR, SpO₂, and EDG. With the patient in the left decubitus position, subarachnoid and epidural blocks were performed, and epidural puncture was carried out in the L1-2 space. 3ml of 2% lidocaine was injected, followed by the observation of the signs of general spinal anesthesia of the patients 5 minutes later. If no sign of general spinal anesthesia was observed, the patient was maintained in the lateral recumbent position and the dose of anesthetic drugs was increased (Viderman *et al.*, 2021).

The control group also received 10ml of 0.75% ropivacaine combined with 1ml of normal saline through injection from the epidural space of the patients at a rate of 0.5ml/s.

The observation group received 10ml of 0.75% ropivacaine plus 10μg of sufentanil through injection from the epidural cavity at a rate of 0.5ml/s. The dose was increased as per the patient's condition.

Evaluation criteria

(1) Anesthesia effect. The effect is divided into three categories: good, moderate, and poor. Good: The abdominal muscles were completely relaxed, and the operation was uneventful; moderate: The abdominal muscles were relaxed, and the operation was uneventful with slight intestinal swelling caused by the pulling of the internal organs; poor: The abdominal muscles were not satisfactorily relaxed, and the operation was interrupted due to severe bloating reaction caused by the pulling of the internal organs during the operation.

(2) Postoperative pain score. The visual analogue scale (VAS) was used for evaluation, with a total score of 10 points, and the score was proportional to the severity of pain. A score of 3 indicates mild pain, a score of 4-6 indicates moderate pain, which requires adjuvant treatment with analgesics, and a score of 7-10 indicates intolerable severe pain.

(3) Sedation score. Ramsay sedation score (RSS) was used to assess the sedation, with a range of 1-6 points. 1 point: the patient is awake but anxious; 2 points: the patient is awake, quiet, and cooperative, with good orientation; 3 points: the patient is awake and responsive to instructions; 4 points: the patient is asleep, and responds quickly to light taps on the glabella or loud sound stimuli; 5 points: the patient is asleep, and responds slowly to the light tap or loud sound stimulation; 6 points: the patient is asleep, and shows no response to the light tap or loud sound stimulation.

(4) Adverse reactions. The occurrence of adverse reactions in the two groups was recorded in detail, including hypotension, nausea and vomiting, dyspnea, and arrhythmia, and the total incidence of the two groups was calculated.

STATISTICAL ANALYSIS

The normality of the sample was determined with the Shapiro–Wilk test. Descriptive statistical data were evaluated with the exploratory analyses of the Tukey test. Quantitative mean data (PES/WES, ISQ, and B.L.) were assessed with the nonparametric Wilcoxon–Mann–Whitney U-test to analyze the inferential statistics.

Statistical analysis was performed using SPSS Statistics 18.0 software for Windows (SPSS Inc., Chicago, IL). The paired *t*-test was performed to compare the differences in measurement data ($\bar{X} \pm s$), and the chi-square test was performed to compare the differences in enumeration data [*n* (%)]. All statistical significance levels were set at a *P* value of less than .05.

RESULTS

Anesthesia effect

In the control group, there were 22 cases of excellent effects, 25 cases of moderate effects, and 13 cases of poor effects. In the observation group, there were 31 cases of excellent effects, 27 cases of moderate effects, and 2 cases of poor effects. Ropivacaine plus sufentanil was associated with significantly better anesthetic effects versus ropivacaine for epidural anesthesia (96.66% vs 78.33%) ($P < 0.05$). (table 2)

Postoperative VAS score

The VAS scores (1.51 ± 0.84 , 1.63 ± 0.56 , 1.69 ± 0.63 , 1.54 ± 0.42) of the observation group at 4h, 8h, 16h, and 24h after operation were significantly lower than those of the control group (2.35 ± 0.88 , 2.49 ± 0.69 , 2.47 ± 0.78 , 2.39 ± 0.58) ($P < 0.05$). (table 3)

Postoperative RSS score

The RSS scores (1.98 ± 0.81 , 2.44 ± 0.62 , 2.18 ± 0.62 , 2.51 ± 0.37) of the observation group at 4h, 8h, 16h, and 24h after operation were significantly lower than those of the control group (1.42 ± 0.52 , 1.73 ± 0.71 , 1.47 ± 0.66 , 1.68 ± 0.62) ($P < 0.05$). (table 4)

Adverse reactions

In the control group, there were 3 (5.00%) cases of hypotension, 8 (13.34%) cases of nausea and vomiting, 5 (8.34%) cases of dyspnea, and 2 (3.34%) cases of arrhythmia. In the observation group, 1 case (1.67%) of hypotension, 1 case of nausea and vomiting (1.67%), 1 case of dyspnea (1.67%), and 0 cases of arrhythmia (0.00%). The total incidence of adverse reactions in the observation group was significantly lower than in the control group (5.00% vs 30.00%) ($P < 0.05$) (table 5).

DISCUSSION

Elderly patients are usually associated with multiple comorbidities, decreased function of various organs, reduced tolerance to surgery and anesthesia, and increased risk of anesthesia. Decreased cardiac function and cardiovascular regulation in elderly patients predispose them to hypotension during anesthesia and poor compensatory response to hypotension, hypovolemia, and hypoxia, which may easily cause an imbalance in blood and oxygen supply to the heart, thus inducing myocardial ischemia and even myocardial infarction (Bi *et al.*, 2021).

Decreased pulmonary compliance and pulmonary elastic retraction pressure lead to decreased pulmonary function, increased lung function residual air volume, easy hypoxia during anesthesia and surgery, and decreased tolerance to hypoxia. Moreover, some elderly patients have a history of long-term smoking, comorbid chronic bronchitis, and chronic obstructive pulmonary disease, resulting in worse

Table 1: Comparison of general data of the two groups of patients ($\bar{X} \pm s$)

Groups	n	Gender		Age (year)		Weight (kg)		ASA grade	
		Male	Female	Range	Mean	Range	Mean	I	II
Control group	60	34	26	28-66	39.23±5.21	44-80	59.84±10.21	41	19
Observation group	60	31	29	25-69	40.21±5.98	45-82	60.03±9.98	39	21
t	-	-	-	-	0.957	-	0.103	-	-
P	-	-	-	-	0.341	-	0.918	-	-

Table 2: Comparison of anesthesia effects between the two groups of patients (%)

Groups	n	Good	Moderate	Poor	Total
Control group	60	22 (36.67)	25 (41.67)	13 (21.67)	47 (78.33)
Observation group	60	31 (51.67)	27 (45.00)	2 (3.34)	58 (96.66)
χ^2	-	9.219			
P	-	0.002			

Table 3: Comparison of VAS scores between the two groups of patients ($\bar{X} \pm s$)

Groups	n	4h after surgery	8h after surgery	16h after surgery	24h after surgery
Control group	60	2.35±0.88	2.49±0.69	2.47±0.78	2.39±0.58
Observation group	60	1.51±0.84	1.63±0.56	1.69±0.63	1.54±0.42
t	-	5.348	7.496	6.026	9.194
P	-	<0.001	<0.001	<0.001	<0.001

Table 4: Comparison of RSS scores between the two groups of patients ($\bar{X} \pm s$)

Groups	n	4h after surgery	8h after surgery	16h after surgery	24h after surgery
Control group	60	1.42±0.52	1.73±0.71	1.47±0.66	1.68±0.62
Observation group	60	1.98±0.81	2.44±0.62	2.18±0.62	2.51±0.37
t	-	4.507	5.835	6.073	8.905
P	-	<0.001	<0.001	<0.001	<0.001

Table 5: Comparison of adverse reactions in the two groups of patients (%)

Groups	n	low blood pressure	Nausea and vomiting	Difficulty breathing	Arrhythmia	Total
Control group	60	3 (5.00)	8 (13.34)	5 (8.34)	2 (3.34)	18 (30.00)
Observation group	60	1 (1.67)	1 (1.67)	1 (1.67)	0 (0.00)	3 (5.00)
χ^2	-	12.987				
P	-	<0.001				

tolerance to hypoxia and high postoperative pulmonary-related complications. Elderly patients with reduced neurological function are prone to brain damage or cognitive dysfunction after surgery, which requires proper dosing of central neurosuppressive drugs (Chen *et al.*, 2020). In elderly patients, the metabolism and clearance of anesthetic drugs are slowed due to reduced liver and kidney function. Therefore, the dosage of anesthetic drugs for elderly patients necessitates comprehensive consideration, especially for general anesthetic drugs. In the elderly, with the decreased physiological function of organs and increased pain thresholds, adequate analgesia is essential to reduce myocardial ischemia, hypertension, arrhythmias, and pulmonary disease complications. However, excessive anesthesia is prone to the risk of hypoxia, hypotension, arrhythmias, and impaired

consciousness (Wang *et al.*, 2022). Hence, it is particularly important to adopt a safe and effective anesthesia method for surgery.

Epidural blocks are commonly used in anesthetic management for abdominal surgery. Ropivacaine is the first pure L-body long-acting amide local anesthetic and an aminoamide local anesthetic. It provides a reversible inhibition of impulse conduction along nerve fibers by preventing the entry of sodium ions into the nerve fiber cell membrane, resulting in anesthesia and analgesia. Ropivacaine at a low dose can produce sensory block (analgesia) with only limited non-progressive motor block (Simmons *et al.*, 2019). Sufentanil is a potent narcotic analgesic, similar in structure and action to fentanyl, which undergoes extensive biotransformation in the liver

to form N-dealkyl and O-demethyl metabolites and is excreted via the kidney. At a dose of 8µg/kg (Bauer *et al.*, 2018), sufentanil can achieve deep anesthesia, with a stronger analgesic effect than that of fentanyl.

The findings of this study demonstrated that ropivacaine plus sufentanil resulted in a significantly higher anesthetic effect and lower VAS scores versus ropivacaine, suggesting that the effect of opioids plus local anesthetics for epidural anesthesia and postoperative analgesia outperforms that of local anesthetics alone. The possible explanation is that sufentanil is a new type of opioid analgesics with high-fat solubility, binds to the μ receptors on the surface of the spinal cord to produce analgesic effect with no motor blocking effect, and is suitable for epidural, intrathecal, and multiple routes of analgesia. The combined use of ropivacaine and sufentanil has greater anesthesia intensity, longer duration of action, and better natural anesthesia effect, which were similar to previous study (Kissin *et al.*, 2021).

The reason may be that the propyl group in the structure of ropivacaine replaces the nitrogen atom in the third atom of the piperidine ring, resulting in lower cardiac and neurotoxicity than bupivacaine, which has been gradually and widely used in recent years for intralesional anesthesia. Ropivacaine is less lipid soluble, reaches the gross motor nerve with delayed duration, and has a separation of motor and sensory compared to bupivacaine. Motor nerve blockade correlates with drug concentration, with 0.2% concentrations acting mainly on sensory nerves with little motor block, while 0.75% concentrations produce better motor block. Thus, ropivacaine provides lower cardiovascular and neurotoxicity, faster recovery from the motor nerve block, and better analgesic effects than other local anesthetics, thereby facilitating early postoperative activity. Sufentanil is a pure μ -receptor agonist and a derivative of fentanyl. Intrathecal injection of sufentanil acts directly on opioid receptors in spinal ganglia to produce analgesia, shorten the onset of sensory block, and prolong the duration of sensory blocks without increasing sympathetic block and affecting the plane of sensory block (Simmons *et al.*, 2019).

The RSS scale is currently the most widely used clinical sedation subjectivity scoring standard, which can more accurately reflect the patient's sedation depth and state of consciousness. The present study found that the RSS scores were significantly lower than those in the control group, indicating that the patients in the observation group had better postoperative sedation, which may be attributed to the fact that ropivacaine alone could not completely block the splanchnic nerve, the splanchnic reaction during the operation may interrupt the surgery. However, patients who received ropivacaine plus sufentanil are mildly sedated after surgery, as sufentanil is an opioid receptor agonist acting on the surface of the

spinal cord, which inhibits visceral stimulation, and the combined use of the two drugs enhances the effect of sensory nerve block without affecting the effect of sympathetic nerve block, so as to achieve a more satisfactory anesthetic effect, and has a positive effect on the sedation state of patients.

After intrathecal injection, sufentanil diffuses in the cerebrospinal fluid to the cephalic side and acts on opioid receptors in the spinal cord or higher centers to produce a sedative effect. However, due to its high lipid solubility, sufentanil penetrates rapidly through the spinal membrane into the lipid-soluble environment of the spinal cord and epidural space after intrathecal injection, preventing diffusion through the cerebrospinal fluid to the cephalad. This may be related to absorption into the bloodstream in the spinal cord or epidural and requires further exploration through blood concentration testing (de Bock *et al.*, 2023).

Moreover, the results of the present study also demonstrated that ropivacaine plus sufentanil led to fewer adverse reactions, suggesting that the combined use of ropivacaine and sufentanil features a higher safety profile. The reason is that epidural opioids are absorbed by local blood vessels and subsequently pass across the blood-brain barrier to bind to central spinal cord opioid receptors or pass through the dura and cerebrospinal fluid. Moreover, the quantity of epidural space is minimal, around 10%-20% of the intravenous amount. Low-dose local anesthetic combined with sufentanil epidural analgesia can minimize the toxic and side effects of local anesthetics, with fewer adverse reactions, which is consistent with the results of previous studies (Zhang *et al.*, 2023).

The limitations of this study lie in the narrow concentration range gradient set for ropivacaine and the absence of independent disease testing or stratified testing. In addition, this study failed to exclude the impact of intraoperative bleeding and infusion on the experimental results, which may interfere with the assessment of vital signs, while the sample size was small and the data may be biased, which needs to be further explored by multicenter and large sample experiments. The clinical performance of intrathecal sufentanil at different doses was observed in this study, but the mechanism of intrathecal injection is poorly understood, which necessitates further investigation.

CONCLUSION

In abdominal surgery, ropivacaine plus sufentanil epidural anesthesia resulted in reduced postoperative pain, enhanced sedative effects, and a lower risk of adverse reactions versus ropivacaine alone.

REFERENCES

- Bi Y and Zhou J (2021). Spinal subdural hematoma and subdural anesthesia following combined spinal-epidural anesthesia: A case report. *BMC Anesthesiol.*, **21**(1): 130.
- Bauer C, Pavlakovic I, Mercier C, Maury JM, Koffel C, Roy P and Fellahi JL (2018). Adding sufentanil to ropivacaine in continuous thoracic paravertebral block fails to improve analgesia after video-assisted thoracic surgery: A randomised controlled trial. *Eur. J. Anaesthesiol.*, **35**(10): 766-773.
- Chen G, Gong M and Liu Y (2020). Comparison of ropivacaine plus sufentanil and ropivacaine plus dexmedetomidine for labor epidural analgesia: A randomized controlled trial protocol. *Medicine (Baltimore)*, **99**(36): e22113.
- Cheng Q, Bi X, Zhang W, Lu Y and Tian H (2019). Dexmedetomidine versus sufentanil with high- or low-concentration ropivacaine for labor epidural analgesia: A randomized trial. *J. Obstet. Gynaecol. Res.*, **45**(11): 2193-2201.
- de Bock S, Wijburg CJ and Koning MV (2023). Postoperative effects and complications of intrathecal morphine compared to epidural analgesia in patients undergoing intracorporeal robot-assisted radical cystectomy: A retrospective study. *BMC Anesthesiol.*, **23**(1): 174.
- Farghali M, Ibrahim AS and Farrag WS (2022). Epidural anaesthesia and myomectomy-associated blood loss - a prospective randomised controlled study. *Ginekol Pol.*, **93**(11): 861-866.
- Homma T, Shimada Y and Tanabe K (2022). Decreased postoperative complications, neuropathic pain and epidural anesthesia-free effect of uniportal video-assisted thoracoscopic anatomical lung resection: A single-center initial experience of 100 cases. *J. Thorac. Dis.*, **14**(9): 3154-3166.
- Kissin I (2021). High-Impact clinical studies that fomented new developments in anesthesia: History of achievements, 1966-2015. *Drug Des. Devel. Ther.*, **15**: 2495-2505.
- López Álvarez S, Casas Reza P and Del Río Fernández S (2022). Centenary of epidural anaesthesia. *Rev. Esp. Anesthesiol. Reanim. (Engl Ed)*, **69**(1):4-11.
- Li G, Xiao Y, Qi X, Wang H, Wang X, Sun J, Li Y and Li Y (2020). Combination of sufentanil, dexmedetomidine and ropivacaine to improve epidural labor analgesia effect: A randomized controlled trial. *Exp. Ther. Med.*, **20**(1): 454-460.
- Martin-Flores M (2019). Epidural and spinal anesthesia. *Vet. Clin. North Am. Small Anim. Pract.* **49**(6): 1095-1108.
- Simmons SW, Dennis AT, Cyna AM, Richardson MG and Bright MR (2019). Combined spinal-epidural versus spinal anaesthesia for caesarean section. *Cochrane Database Syst. Rev.*, **10**(10): CD008100.
- Viderman D, Ben-David B and Sarria-Santamera A (2021). Analysis of bupivacaine and ropivacaine-related cardiac arrests in regional anesthesia: A systematic review of case reports. *Rev. Esp. Anesthesiol. Reanim. (Engl Ed)*, **68**(8): 472-483.
- Wang Y, Chen Z, Dang X, Jiang N, Cui K and Su S (2022). Different doses of ropivacaine either with sufentanil or with dexmedetomidine for labor epidural anesthesia regarding painless childbirth: A retrospective, multicenter study. *Pharmacology*, **107**(7-8): 386-397.
- Zhang Y, Lv X, Sun P and Yin D (2023). Sufentanil, dexmedetomidine combined with surface anesthesia for awake fiberoptic nasotracheal intubation in the patient with severe mouth opening difficulty undergoing wedge resection of the right upper lung: A case report and literature review. *Medicine (Baltimore)*, **102**(16): e33584.