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Analysis of the Effects of Combined Spinal-Epidural Anesthesia and Epidural Anesthesia in Appendicitis Surgery at Primary Hospitals

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Abstract: *Objective*: To analyze the effects of combined spinal-epidural anesthesia and epidural anesthesia in patients undergoing appendicitis surgery. *Methods*: Seventy-eight patients who underwent surgical treatment for appendicitis from February 2022 to February 2025 were selected as samples and randomly divided into two groups. The study group received combined spinal-epidural anesthesia, while the control group received epidural anesthesia. Anesthesia indicators, vital signs, and complication indicators were compared between the two groups. *Results*: The onset time of anesthesia in the study group was shorter than that in the control group, the visual analog scale (VAS) score was lower than that in the control group, and the highest plane of anesthesia block was lower than that in the control group ($P < 0.05$). At 15 minutes after anesthesia induction and at the end of surgery, the heart rate (HR), mean arterial pressure (MAP), and blood oxygen saturation (SPO2) in the study group were significantly different from those in the control group ($P < 0.05$). The complication rate in the study group was lower than that in the control group ($P < 0.05$). *Conclusion*: Combined spinal-epidural anesthesia for appendicitis surgery can reduce the impact of anesthesia on vital signs, shorten the onset time of anesthesia, and is highly effective and feasible.

Keywords: Appendicitis surgery; Epidural anesthesia; Combined spinal-epidural anesthesia; Pain

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1. Introduction

Appendicitis is a relatively common disease among surgical acute abdominal conditions, often presenting with metastatic right lower abdominal pain accompanied by symptoms such as nausea, vomiting, fever, and chills. It is associated with factors like infection and obstruction. Surgical treatment is frequently used for appendicitis, but invasive procedures can exacerbate pain, leading to reduced patient cooperation during surgery. Therefore, it is crucial to perform perioperative anesthesia effectively. Epidural anesthesia is a commonly used anesthetic technique in appendicitis surgery, but it has issues such as long block induction time and incomplete block [1]. Combined spinal-epidural anesthesia, on the other hand, is a modern anesthetic technique that can shorten the onset time of anesthetics and maintain stable vital signs during surgery. Based on this, this study explores the value of combined spinal-epidural anesthesia using a sample of 78 patients who underwent surgical treatment for appendicitis from February 2022 to February 2025.

2. Materials and methods

2.1. Materials

A total of 78 patients who underwent surgical treatment for appendicitis from February 2022 to February 2025 are selected as the sample and randomly divided into groups. The appendicitis data of the study group are compared with those of the control group ($P > 0.05$), as shown in **Table 1**.

Table 1. Analysis of appendicitis data

Group	*n*	Gender(%)		Age (years)		Weight(kg)		ASA Classification	
		Male	Female	Range	Mean	Range	Mean	Grade I	Grade II
Research Group	39	21 (53.85)	18 (46.15)	19–58	49.11 ± 2.09	56–72	66.18 ± 2.28	24(61.54)	15(38.46)
Control Group	39	22 (56.41)	17 (43.59)	19–57	49.18 ± 2.11	56–71	66.21 ± 2.31	25(64.10)	14(35.90)
X^2/t	-	0.0518		0.1472		0.0577		0.0549	
P	-	0.8199		0.8834		0.9541		0.8148	

2.2. Inclusion and exclusion criteria

The inclusion criteria of the study are: (1) Acute appendicitis confirmed by ultrasound, CT, or pathology; (2) Signed informed consent by the patient or family members; (3) Presence of symptoms such as metastatic right lower abdominal pain, tenderness or rebound pain at McBurney's point; (4) Presence of surgical indications; (5) Adult patients aged ≥ 18 years.

Meanwhile, the exclusion criteria are: (1) Abnormal coagulation system; (2) Cardiovascular disease; (3) Liver and kidney disease; (4) Poor tolerance to ropivacaine; (5) Pregnancy or high surgical difficulty, combined with other infections; (6) Patients undergoing complex and non-surgical treatment.

2.3. Methods

2.3.1. Control group

The epidural puncture point is determined at the T12–L1 intervertebral space. After successful puncture and catheter placement, patients are placed in a supine position. A Around 3–5 ml of 2% lidocaine hydrochloride is injected. If no discomfort occurred after 5 minutes, 8–10 ml of 2% lidocaine is injected, and additional anesthetics are administered based on the surgical requirements for appendicitis.

2.3.2. Observation group

Combined spinal-epidural anesthesia is performed. Based on the epidural anesthesia procedure, a spinal needle is inserted through the L3–4 intervertebral space, and cerebrospinal fluid is allowed to flow out. A mixture of 2ml of 0.75% ropivacaine and 10% glucose solution is injected at a controlled injection speed of 0.2ml/s to maintain the T6 anesthesia level. The anesthetic dose is adjusted based on the surgical requirements for appendicitis.

2.4. Observation indicators

(1) Anesthesia indicators: Record the onset time of anesthesia, VAS score (0 for no pain, 10 for severe pain, with the score proportional to the level of pain), and the highest plane of anesthesia blockade (determined by pinprick pain measurement before the start of surgical operation but after the onset of anesthesia).

(2) Vital signs: Monitor HR, MAP, and SPO2 indicators before anesthesia, 15 minutes after anesthesia, and at the end of surgery.

(3) Complications: Record hypotension, lower back pain, nausea and vomiting, and headache.

2.5. Statistical analysis

SPSS 23.0 is used to process the data. The X^2 test is used for counting data (recorded as %), and the t-test is used for measurement indicators (recorded as $\bar{x} \pm s$). Statistical significance is set at $P < 0.05$.

3. Results

3.1. Anesthesia indicators

The study group had a shorter onset time of anesthesia, lower VAS score, and lower highest plane of anesthesia blockade compared to the control group, with $P < 0.05$. The result is shown in **Table 2**.

Table 2. Anesthesia indicators ($\bar{x} \pm s$)

Group	Anesthesia onset time (min)	VAS score (points)	Maximum anesthesia block level (cm²)
Research group (*n*=39)	2.12 ± 0.42	2.14 ± 0.48	5.64 ± 0.21
Control group (*n*=39)	5.11 ± 0.69	4.33 ± 0.69	7.11 ± 0.36
t	23.1160	16.2712	22.0267
P	0.0000	0.0000	0.0000

3.2. Vital signs indicators

At 15 minutes after anesthesia and at the end of surgery, there were differences in HR, MAP, and SPO_2 indicators between the study group and the control group. The study group showed smaller changes and more stable vital signs, with $P < 0.05$. The results are shown in **Table 3**.

Table 3. Vital signs indicators ($\bar{x} \pm s$)

Group	HR(times/min)			MAP(mmHg)			SPO2(%)		
	Pre-anesthesia	15 min after anesthesia	End of surgery	Pre-anesthesia	15 min after anesthesia	End of surgery	Pre-anesthesia	15 min after anesthesia	End of surgery
Research group (*n*=39)	76.29 ± 1.25	68.41 ± 1.05	69.11 ± 1.11	93.18 ± 2.43	81.46 ± 1.25	83.16 ± 1.42	97.48 ± 1.81	93.41 ± 1.57	95.42 ± 1.72
Control group (*n*=39)	76.31 ± 1.26	75.25 ± 1.13	78.43 ± 1.32	93.21 ± 2.45	86.49 ± 1.68	89.62 ± 1.78	97.52 ± 1.83	90.18 ± 1.36	93.68 ± 1.44
t	0.0704	27.6920	33.7475	0.0543	15.0010	17.7174	0.0971	9.7111	4.8441
P	0.9441	0.0000	0.0000	0.9568	0.0000	0.0000	0.9229	0.0000	0.0000

3.3. Complication indicators

The complication rate of the study group was lower than that of the control group, ($P < 0.05$), as shown in **Table 4**.

Table 4. Complication indicators (n,%)

Group	Hypotension	Lower back pain	Nausea and vomiting	Headache	Incidence rate
Research group (*n*=39)	1(2.56)	0(0.00)	0(0.00)	0(0.00)	1(2.56)
Control group (*n*=39)	2(5.13)	2(5.13)	1(2.56)	1(2.56)	6(15.38)
X^2	-	-	-	-	3.9235
P	-	-	-	-	0.0476

4. Discussion

The inducements of appendicitis are mainly related to factors such as bacterial infection, obstruction of the appendiceal lumen, and congenital malformations of the appendix. It often occurs acutely, and its pathological feature is severe lower abdominal pain. In addition, if acute appendicitis is not treated early, it can progress to chronic appendicitis. Surgery is often used to treat appendicitis clinically, but surgical resection can exacerbate the patient's pain and even cause a series of discomforting symptoms. Therefore, attention should be paid to the management of anesthesia for appendicitis, and anesthetic methods should be reasonably selected to alleviate the patient's pain. Epidural anesthesia has a high application rate in appendicitis surgery. Injecting anesthetic drugs through the dura mater into the yellow ligament space can anesthetize the nerve roots in the target area. Moreover, the epidural space and cranial cavity in the human body are not connected, so the injection of anesthetic drugs will not cause paralysis of the medulla oblongata [2].

However, it should be noted that patients receiving epidural anesthesia may experience myocardial inhibition and vasodilation due to the anesthetic effect on sympathetic nerves, increasing the risk of intraoperative bradycardia and hypotension. Additionally, epidural anesthesia alone cannot block the vagus nerve. Therefore, surgical exploration of the appendix can stimulate the muscles, leading to problems such as increased muscle tone, pain, and vomiting. To ensure the smooth progress of surgical operations, the dosage of anesthetic drugs should be increased, highlighting the limitations of epidural anesthesia alone [3]. Subarachnoid anesthesia refers to the injection of anesthetic drugs into the subarachnoid space before appendicitis surgery to block nerve tissue, which can shorten the onset time of anesthesia.

However, during lumbar anesthesia, there is a risk of cerebrospinal fluid leakage due to the puncture of the dura mater, increasing the risk of post-anesthesia headache. Additionally, it is not possible to adjust the drug dosage intraoperatively according to the patient's actual needs during lumbar anesthesia alone [4]. In recent years, combined spinal-epidural anesthesia has gradually been used in perioperative anesthesia for appendicitis, integrating the advantages of both techniques. This approach can enhance the anesthetic effect, reduce the drug dosage, shorten the onset time of anesthetic blockade, and ensure high safety. It can also avoid the problem of physiological muscle tone increase caused by intraoperative traction. Furthermore, during combined spinal-epidural anesthesia, anesthetic drugs quickly reach the spinal nerve roots to provide analgesia, shortening the onset time of anesthesia. It can also relax abdominal muscles and muscles adjacent to the appendix, facilitating surgical operations and reducing unnecessary intraoperative injuries [5].

Based on the data analysis in this paper, the anesthesia onset time of the study group was shorter than that of the control group, the VAS score was lower than that of the control group, and the highest level of anesthesia block was lower than that of the control group, with $P < 0.05$. The reason for this is that patients with appendicitis receiving epidural anesthesia alone can experience analgesia after the injection of anesthetics, but it can easily induce vasodilation issues. Additionally, under the influence of myocardial depression, problems such as bradycardia and hypotension are likely to occur. Moreover, epidural anesthesia does not block the vagus nerve, so when the surgeon explores the appendix, it can increase reflex muscle tone, leading to a weakening of the analgesic effect, requiring continuous addition of anesthetics to ensure the smooth progress of the surgical operation. The combination of spinal and epidural anesthesia integrates the advantages of both methods.

During spinal anesthesia, the anesthetic enters the subarachnoid space and directly contacts nerve fibers to exert its effect, which can reduce the onset time of the anesthetic [6]. The subarachnoid space is relatively closed, allowing the anesthetic to quickly spread to adjacent nerve fibers after injection. Furthermore, due to the fluidity of cerebrospinal fluid, the anesthetic can spread with it, further reducing the onset time. Additionally, during combined spinal and epidural anesthesia, the active ingredients of the anesthetic directly block the spinal nerve roots, enhancing the analgesic effect in the surgical area. The surgeon can flexibly adjust the level of anesthesia by adjusting the dose and administration speed of the anesthetic, which can avoid the risk of complications caused by excessively high anesthesia levels [7]. Another set of data showed that at 15 minutes after anesthesia and at the end of the surgery, there were significant differences in HR, MAP, and SPO2 between the study group and the control group ($P < 0.05$), indicating more stable vital signs in the combined spinal and epidural anesthesia group. This is because combined spinal and epidural anesthesia has a high application rate in spinal block, facilitating anesthesiologists to adjust the anesthesia level and enhance the analgesic effect.

Additionally, the combined block has a slight sympatholytic effect, which facilitates surgical operations and results in more stable patient vital signs. During combined spinal and epidural anesthesia, ropivacaine is often chosen for anesthesia. Its chemical structure is similar to that of bupivacaine, but it has a more durable anesthetic effect. As an amide local anesthetic, it can exert a sensory-motor blockade effect, which is beneficial for reducing complications in the circulatory and respiratory systems, resulting in higher medication safety [8]. Finally, data showed that the postoperative complication rate of appendicitis in the study group was lower than that in the control group ($P < 0.05$). The reason for this is that combined spinal and epidural anesthesia allows surgeons to flexibly adjust the anesthesia level, reducing the incidence of hypotension caused by abnormal increases in anesthesia level. The active ingredients of the combined anesthesia exert their effects at the spinal cord and spinal nerve roots, which can reduce traction on nerve roots during appendectomy and relax muscles, thereby reducing the risk of lower back pain. The rapid onset of combined anesthesia can also reduce stress responses, stabilize the neuroendocrine system, and slow down gastrointestinal contractions, thereby reducing the incidence of nausea and vomiting [9].

In addition, combined anesthesia can reduce cerebrospinal fluid loss and stabilize intracranial pressure, thereby reducing postoperative headache. Furthermore, the low dose of medication used in combined spinal and epidural anesthesia can reduce the paralysis of sympathetic nerves caused by induction drugs, further reducing the risk of anesthetic adverse reactions and enhancing the safety of appendicitis surgery [10]. However, regardless of the anesthesia method chosen, there are anesthesia risks involved in appendicitis surgery. In this study, one patient in the combined spinal and epidural anesthesia group experienced hypotension. This occurred when lidocaine was injected into the subarachnoid space, resulting in a rapid decrease in blood pressure. The injection of the anesthetic was immediately suspended, and the patient was treated with vasopressors and fluid replacement, resulting in gradual stabilization of blood pressure. After reducing the dose of lidocaine, the anesthesia was completed without further hypotension issues. This case of hypotension may be related to an excessively high anesthesia level, where the active ingredients of lidocaine rapidly spread with the cerebrospinal fluid, leading to widespread sympathetic nerve block, abnormal cardiovascular compensation, subsequent bradycardia, and rapid blood pressure decrease.

To ensure the effectiveness of combined spinal and epidural anesthesia, it is necessary to guide patients with appendicitis to fast for 6–8 hours before surgery to prevent perioperative aspiration and vomiting events. Anesthesia operations should be performed following aseptic principles to prevent perioperative infections. Gentle and slow puncture operations should be performed to protect nerve roots and the spinal cord as much as possible, and the depth and direction of the puncture needle should be adjusted based on actual conditions to ensure that the anesthetic reaches the subarachnoid space and epidural space smoothly. After completing the anesthesia operation, electrocardiographic monitoring should be performed, and changes in HR, MAP, SPO2, and other indicators should be recorded.

5. Conclusion

In summary, the use of combined spinal and epidural anesthesia in patients undergoing appendicitis surgery can stabilize vital signs, shorten the onset time of anesthesia, enhance the analgesic effect, and reduce anesthetic adverse reactions, making it worthy of promotion.

Disclosure statement

The author declares no conflict of interest.

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