Effect of Intraspinal Anesthesia on Postoperative Recovery in Elderly Patients with Acute Appendicitis: A Retrospective Study

Ann. Ital. Chir., 2024 95, 4: 669–677
https://doi.org/10.62713/aic.3415

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AIM: Acute appendicitis is a common disease in the elderly. Exploring a suitable anesthesia method is crucial in promoting postoperative recovery in elderly patients. Therefore, this study aimed to investigate the clinical effect of intraspinal anesthesia in elderly patients with appendicitis.

METHODS: This study included the clinical data of 217 elderly patients with acute appendicitis who underwent laparoscopic appendectomy (LA) at Tianjin Hospital of Tianjin University from January 2022 to January 2023. After excluding 8 patients who did not meet the inclusion criteria, the data from 209 patients were retrospectively analyzed. Based on the different anesthesia methods, the study participants were divided into a reference group (n = 106) and a study group (n = 103). We compared the heart rate (HR), respiratory rate (RR), systolic blood pressure (SBP), diastolic blood pressure (DBP), blood oxygen saturation (SaO2), operation duration, hospitalization costs, discharge time, postoperative adverse reactions, inflammatory factor levels, Visual Analogue Scale (VAS) score, recovery time of intestinal peristalsis, anal exsufflation time, out-of-bed time, and incidence of postoperative complications between the two experimental groups.

RESULTS: We observed that the study group exhibited higher levels of HR, RR, SBP, DBP, and SaO2 compared to the reference group ($p < 0.001$). However, there was no difference in operation time between the two groups ($p > 0.05$). The study group showed lower hospitalization cost and shorter discharge time than the reference group ($p < 0.001$). Similarly, the study group had lower incidence of postoperative adverse reactions than reference group ($p < 0.05$). There were no significant differences in the levels of C-reactive protein, interleukin-6, and tumor necrosis factor-α between the two groups before and after surgery ($p > 0.05$). Furthermore, the study group had a lower VAS score compared to the reference group at 3 h, 6 h and 12 h after surgery ($p < 0.001$). The recovery time of intestinal peristalsis, anal exsufflation time, and out-of-bed time in the study group were substantially shorter than the reference group ($p < 0.001$). Additionally, there was no difference in the incidence of postoperative complications between the two groups within 1 year after surgery ($p < 0.001$).

CONCLUSIONS: Intraspinal anesthesia, as a safe anesthesia method, can reduce the discharge time of elderly patients with acute appendicitis who underwent LA, and reduce the occurrence of adverse reactions, and is beneficial for postoperative recovery.

Keywords: intraspinal anesthesia; elderly patients with acute appendicitis surgery; postoperative recovery; retrospective study

Introduction

Acute appendicitis is the leading reason for abdominal surgery in emergency department worldwide and a common cause of medical visit in emergency department [1]. The annual incidence of this disease is about one in a thousand. Appendectomy is the preferred treatment for acute appendicitis across all age groups [2]. In recent years, laparoscopic appendectomy (LA) has gradually replaced open appendectomy and become the golden standard treatment for uncomplicated appendicitis [3]. The epidemiological outcomes of acute appendicitis in elderly patients differ from those in younger individuals. Elderly patients with acute appendicitis experience higher mortality rates, a higher incidence of postoperative complications, and a higher risk of colon cancer and appendiceal carcinoma [4]. Therefore, the safety and efficacy of LA treatment in elderly patients with acute appendicitis need further improvement.

Anesthesia is an essential part of the surgical process. The appropriate anesthesia method is crucial for achieving optimal postoperative analgesia [5]. Intraspinal anesthesia can be divided into spinal anesthesia, epidural anesthesia, combined spinal-epidural anesthesia (CSEA), and caudal block, based on different injection sites of anesthetic drugs [6]. LA is usually performed under general anesthesia rather than regional anesthesia. A study assessing the feasibility, efficacy, and side effects of CSEA over the years reported it to be an efficient and suitable anesthetic technique for healthy patients, effectively managing postoperative pain and complications [7]. Furthermore, a study has demon-

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strated that intraspinal anesthesia is a safe alternative to general anesthesia, though it has not been widely applied in clinical practice. This is due to the limited flexibility in the duration of intraspinal anesthesia and the risk of postoperative urinary retention [8]. Elderly patients are a distinct group, as aging leads to anatomical and physiological changes in the brain, making it more sensitive to the effect of anesthetic drugs and increasing the risk of postoperative complications [9]. Therefore, it is crucial to explore safer methods of anesthesia to improve the prognosis of elderly patients undergoing LA. Hence, this study aims to confirm the clinical efficacy and safety of intraspinal anesthesia in elderly appendicitis patients.

Materials and Methods

Study Participants

This study included the clinical data of 217 elderly patients with acute appendicitis who underwent LA at Tianjin Hospital of Tianjin University from January 2022 to January 2023. After excluding 8 patients who did not meet the inclusion criteria, the data from 209 patients were retrospectively analyzed. Based on the different anesthesia methods, the study participants were divided into a reference group (n = 106) and a study group (n = 103). All patients provided informed consent, and the study design followed the Declaration of Helsinki (2013) [10]. Furthermore, the study design was approved by the ethics committee of Tianjin Hospital of Tianjin University (approval No.: 2021TJ011).

Inclusion criteria were as follows: (1) Patients were $\geq$60 years old. (2) Patients had obvious tenderness at McBurney point in the right lower abdomen, accompanied by abdominal pain, nausea and vomiting, fever and other symptoms. Through abdominal ultrasound examination, patients met the diagnostic criteria of acute appendicitis and the surgical indications of LA [11]. (3) Patients had good mental state and clear language expression. (4) Patients had complete clinical data.

Moreover, the exclusion criteria were as follows: (1) Patients had extensive adhesion in the abdominal cavity, who were not suitable for LA treatment. (2) Patients had acute periappendiceal abscess or peritonitis [12]. (3) Recovery time of anesthesia was $>$3 hours. (4) Patients had organic disease. (5) Patients were women in pregnancy or lactation. (6) Patients had coagulation disorders. (7) Patients who were found to have other diseases during operation required simultaneous surgery.

Research Design

The demographic characteristics such as age, gender, weight, and height of all study participants were collected through the electronic medical record system of the hospital. Both experimental groups received LA treatment. Upon entering the operating room, routine intravenous access was established for all individuals, and their electrocardiogram, heart rate (HR), blood pressure, and blood oxygen saturation (SaO2) were monitored.

The reference group received general anesthesia, which included 0.1 mg/kg of midazolam (batch No.: NMPA approval H20010311, manufacturer: Shanghai Roche Pharmaceuticals, Ltd., origin: Shanghai, China), 3 μg/kg of fentanyl (batch No.: NMPA approval H20113508, manufacturer: Jiangsu Nhwa Pharmaceutical Co., Ltd., origin: Xuzhou, China), 1.5 mg/kg of propofol (batch No.: NMPA approval H20123318, manufacturer: Xi'an Libang Pharmaceutical Co., Ltd., origin: Xi'an, China), and 0.8 mg/kg of rocuronium bromide (batch No.: NMPA approval H20123188, manufacturer: Zhejiang Xianju Pharmaceutical Co., Ltd., origin: Taizhou, China). After tracheal intubation, continuous infusions of fentanyl, propofol, and rocuronium bromide were injected, maintaining a bispectral index (BIS) value of 50 $\pm$ 5.

Furthermore, the study group received intraspinal anesthesia. The L_{3-4} was selected as the puncture point, and 0.5% of bupivacaine (batch No.: NMPA approval H50020018, manufacturer: Southwest Pharmaceutical Co., Ltd., origin: Chongqing, China) mixed with 1.8 mL of hyperbaric spinal fluid was injected at a rate of 0.2 mL/s. The 3–4 cm long epidural catheter was inserted towards the head. Based on the duration of the procedure, additional local anesthetics were injected into the spinal canal, adjusting the anesthetic level below T6.

After the recovery of patients' consciousness and the stability of respiration and circulation, physicians escorted them back to the ward after a brief observation.

Observation Indicators

(1) Intraoperative vital signs. An electrocardiogram monitor (batch No.: Mindray uMEC7, manufacturer: Nanjing Beideng Medical Co., Ltd., origin: Nanjing, China) was used to assess the patients' HR (normal range: 60–100 times/min), respiratory rate (RR), blood pressure [including systolic blood pressure (SBP; normal range: 90–139 mmHg) and diastolic blood pressure (DBP; normal range: 60–89 mmHg)], and SaO2 (normal range: 95%–100%).

(2) Operation time, hospitalization costs, and duration were collected from study participants using the electronic medical record system of the hospital.

(3) Adverse reactions. Adverse reactions following surgery, such as headache, urinary retention, shoulder pain, nausea and vomiting, hypotension, bradycardia, and respiratory discomfort, were documented before discharge, and the corresponding proportions were calculated.

(4) Inflammatory factors. The levels of C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor-α (TNF-α) were recorded from the electronic medical record system of the hospital. CRP levels were assessed using immunoturbidimetry assay with corresponding assay kits (batch No.: ml0113184, Beijing Biolab Technology Co.,

Table 1. Comparison of demographic characteristics between the two experimental groups [M (P_{25}, P_{75}), n (%)].

Variables	Reference group (n = 106)	Study group (n = 103)	χ^2/z-value	p-value
Age [years old, M (P_{25}, P_{75})]	67.00 (63.00, 72.00)	67.00 (62.00, 71.00)	–0.617	0.537
Gender			0.011	0.918
Male	61 (57.55)	60 (58.25)		
Female	45 (42.45)	43 (41.75)		
Weight [kg, M (P_{25}, P_{75})]	67.00 (57.00, 79.00)	69.00 (58.00, 81.00)	–0.425	0.671
Height [cm, M (P_{25}, P_{75})]	168.00 (160.00, 175.25)	167.00 (158.00, 176.00)	–0.081	0.935
Pathological types of acute appendicitis			0.117	0.943
Simple appendicitis	41 (38.68)	42 (40.78)		
Acute suppurative appendicitis	36 (33.96)	33 (32.04)		
Gangrenous appendicitis	29 (27.36)	28 (27.18)		
Time from onset to treatment [h, M (P_{25}, P_{75})]	43.00 (24.00, 57.25)	38.00 (22.00, 54.00)	–0.958	0.338
Basic diseases				
Hypertension	53 (50.00)	54 (52.43)	0.123	0.726
Coronary heart disease	28 (26.42)	25 (24.27)	0.127	0.722
Diabetes	42 (39.62)	39 (37.84)	0.068	0.794

Ltd., origin: Beijing, China), where the normal range is 0–4 mg/L. Serum IL-6 levels were determined using the enzyme-linked immunosorbent assay (ELISA) double antibody sandwich method, with a normal level of $<$5.186 pg/mL [13]. The test kits (batch No.: ml028583, Shanghai Enzyme-linked Biotechnology Co., Ltd., origin: Shanghai, China) were purchased from Shanghai Enzyme-linked Biotechnology Co., Ltd. TNF-α levels were evaluated using the ELISA double antibody sandwich method (batch No.: ml002095, manufacturer: Shanghai Enzyme-linked Biotechnology Co., Ltd., origin: Shanghai, China), with the normal range of 0.74–1.54 ng/mL [14]. Patient indicators were assessed one day before surgery and three days after surgery. These reaction plates were examined using an ELISA detection instrument (batch No.: P20180522, manufacturer: Shanghai Jumu Medical Devices Co., Ltd., origin: Shanghai, China). For ELISA sample collection, 3 mL of fasting venous blood was collected from patients in the morning and centrifuged at 3000 r/min for 15 min to obtain the supernatant.

(5) Visual Analogue Scale (VAS) score [15]. The VAS was adopted to assess the patient´s pain level. The VAS scale consists of a 10 cm horizontal line drawn on paper, with one end of 0 cm indicating "no pain", and the other as 10 cm indicating "extreme pain". Pain level increases from 0 cm to 10 cm, representing a scoring range of 0–10 points, where a higher score indicates more severe pain. Pain levels were assessed at 3, 6, and 12 hours after surgery.

(6) Postoperative recovery indexes. The recovery time of intestinal peristalsis, anal exsufflation time, and out-of-bed time in both experimental groups were collected and organized utilizing the electronic medical record system.

(7) Postoperative complications. The occurrence of perioperative complications in study participants was recorded. Postoperative complications were defined as local adhesions, abscesses, and intestinal obstruction. The number of patients with postoperative complications in each experimental group was counted, and the overall incidence was calculated.

Statistical Methods

The data were statistically analyzed using SPSS software (version 26.0; International Business Machines Corporation; origin: Armonk, NY, USA). The enumeration data were expressed as [n (%)], with the test method determined based on the minimum expected frequency. If the minimum expected frequency is $\geq$5, the χ^2 test was used, if it is $<$5, Fisher's exact test was applied. The Shapiro-Wiktest test was used to evaluate whether continuous variables followed a normal distribution within the groups. Continuous variables conforming to normal distribution were expressed as mean $\pm$ standard deviation. An independent t-test was used for comparison between groups, and a paired t-test was applied for comparison within the same group. Continuous variables that did not meet normal distribution were expressed as M (P_{25}, P_{75}). Mann-Whitney U test was performed for comparison between groups and the z-value was calculated. Statistical significance was defined at a p-value < 0.05.

Results

Baseline Characteristics of the Study Participants

We observed no significant difference in the demographic characteristics, such as age, gender, weight, and height, between the two experimental groups ($p > 0.05$, Table 1).

Comparison of Intraoperative Vital Signs between the Two Groups

There were no substantial differences in HR, RR, SBP, DBP, and SaO2 levels between the two experimental groups before surgery ($p > 0.05$). However, we observed

Table 2. Comparison of intraoperative vital signs between the two experimental groups [M (P_{25}, P_{75})].

Variables		Reference group (n = 106)	Study group (n = 103)	*z*-value	*p*-value
HR (times/min)	Before surgery	92.00 (85.00, 102.25)	96.00 (90.00, 103.00)	–1.947	0.052
	During surgery	68.50 (62.00, 75.00)	81.00 (72.00, 92.00)	–7.989	<0.001
RR (times/min)	Before surgery	21.00 (19.00, 22.00)	20.00 (19.00, 22.00)	–0.277	0.781
	During surgery	16.00 (14.75, 17.00)	17.00 (15.00, 19.00)	–4.688	<0.001
SBP (mmHg)	Before surgery	131.50 (122.75, 145.25)	134.00 (123.00, 147.00)	–0.621	0.534
	During surgery	96.00 (87.00, 103.25)	106.00 (95.00, 120.00)	–6.169	<0.001
DBP (mmHg)	Before surgery	82.50 (77.00, 89.25)	85.00 (79.00, 95.00)	–1.791	0.073
	During surgery	63.00 (55.75, 68.25)	68.00 (62.00, 77.00)	–5.571	<0.001
SaO2 (%)	Before surgery	98.00 (96.00, 99.00)	97.00 (96.00, 99.00)	–0.994	0.320
	During surgery	92.00 (90.00, 94.00)	97.00 (95.00, 98.00)	–10.696	<0.001

Note: HR, heart rate; RR, respiratory rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; SaO2, blood oxygen saturation.

Table 3. Comparison of operation time, hospitalization costs, and duration of discharge between the two experimental groups [M (P_{25}, P_{75})].

Variables	Reference group (n = 106)	Study group (n = 103)	*z*-value	*p*-value
Operation time (min)	36.00 (26.00, 45.00)	38.00 (31.00, 48.00)	–1.534	0.125
Hospitalization expenses (thousand CNY)	9.00 (8.00, 11.00)	8.00 (7.00, 9.00)	–7.819	<0.001
Time of discharge (d)	6.00 (5.00, 7.00)	4.00 (3.00, 5.00)	–11.687	<0.001

Not: 1 CNY $\approx$ 0.1375 USD.

that these indexes were significantly higher in the study group compared to the reference group ($p < 0.001$, Table 2) during the surgery.

Operation Time, Hospitalization Costs, and Duration of Discharge in the Two Groups

There was no significant difference in operation time between the two groups ($p > 0.05$). However, the study group indicated lower hospitalization costs and a shorter discharge time than the reference group ($p < 0.001$, Table 3).

Adverse Reactions in the Two Groups

We found that the incidence of intraoperative and postoperative adverse events was significantly lower in the study group compared to the reference group ($p < 0.05$, Table 4).

Inflammatory Indicators in the Two Groups

There were no substantial differences in CRP, IL-6, and TNF-α levels between the two groups ($p > 0.05$, Table 5) before and after surgery.

Comparison of VAS Scores between the Two Groups

The study group had lower VAS scores than the reference group at 3 h, 6 h and 12 h after surgery ($p < 0.001$, Table 6).

Comparison of Postoperative Recovery between the Two Groups

We observed that the recovery time of intestinal peristalsis, anal exsufflation time and out-of-bed time in the study group were shorter than those in the reference group ($p < 0.001$, Table 7).

Postoperative Complications

There was no difference in the incidence of local adhesion, abscess, intestinal obstruction between the two groups within 1 year after surgery ($p > 0.05$, Fig. 1).

Discussion

Acute appendicitis has a higher incidence in the elderly, with severe course of disease in the elderly, which is increasingly recognized [16, 17]. Currently, LA is the golden standard treatment for appendicitis. However, there is still controversy over which anesthesia method is more effective [18]. Due to the poor physical conditions of elderly patients, ensuring their safety during anesthesia is crucial. The overall status of visceral and other organ functions in elderly patients should be comprehensively evaluated before surgery, and the appropriate type of anesthesia should be selected based on the physiological characteristics and pharmacokinetic characteristics of elderly patients. This approach aims to reduce surgical risk, promote LA prognosis, shorten recovery time, and alleviate the occurrence of complications.

In this study, the study group had lower hospitalization costs, shorter discharge time, and lower incidence of adverse reactions compared to the reference group. By comparing basic indicators such as age, gender, weight, and height between the two groups, no substantial differences were observed, indicating that additional factors did not affect the study's findings. This suggests that intraspinal anesthesia may be more beneficial for the postoperative re-

Table 4. Comparison of intraoperative and postoperative adverse events between the two experimental groups [n (%)].

Groups	Headache	Urinary retention	Shoulder pain	Nausea and vomiting	Hypotension	Bradycardia	Respiratory discomfort	Total
Reference group (n = 106)	7 (6.60)	3 (2.83)	3 (2.83)	2 (1.89)	2 (1.89)	0	0	17 (16.04)
Study group (n = 103)	3 (2.91)	1 (0.97)	1 (0.97)	1 (0.97)	1 (0.97)	0	0	7 (6.80)
χ^2								4.389
p								0.036

Table 5. Comparison of inflammatory factors between the two groups [M (P_{25}, P_{75})].

Variables	Time	Reference group (n = 106)	Study group (n = 103)	z-value	p-value
CRP (mg/L)	Before surgery	70.50 (53.00, 94.00)	75.00 (61.00, 102.00)	–1.625	0.104
	After surgery	14.00 (12.00, 17.00)	15.00 (12.00, 17.00)	–0.037	0.971
IL-6 (pg/mL)	Before surgery	155.50 (143.75, 167.00)	155.00 (141.00, 166.00)	–0.394	0.694
	After surgery	15.00 (12.00, 18.00)	15.00 (12.00, 18.00)	–0.053	0.958
TNF-α (ng/mL)	Before surgery	24.64 (22.49, 27.22)	25.68 (23.39, 27.52)	–1.788	0.074
	After surgery	4.17 (3.12, 5.21)	4.02 (3.10, 5.05)	–0.372	0.710

Note: CRP, C-reactive protein; IL-6, interleukin-6; TNF-α, tumor necrosis factor-α.

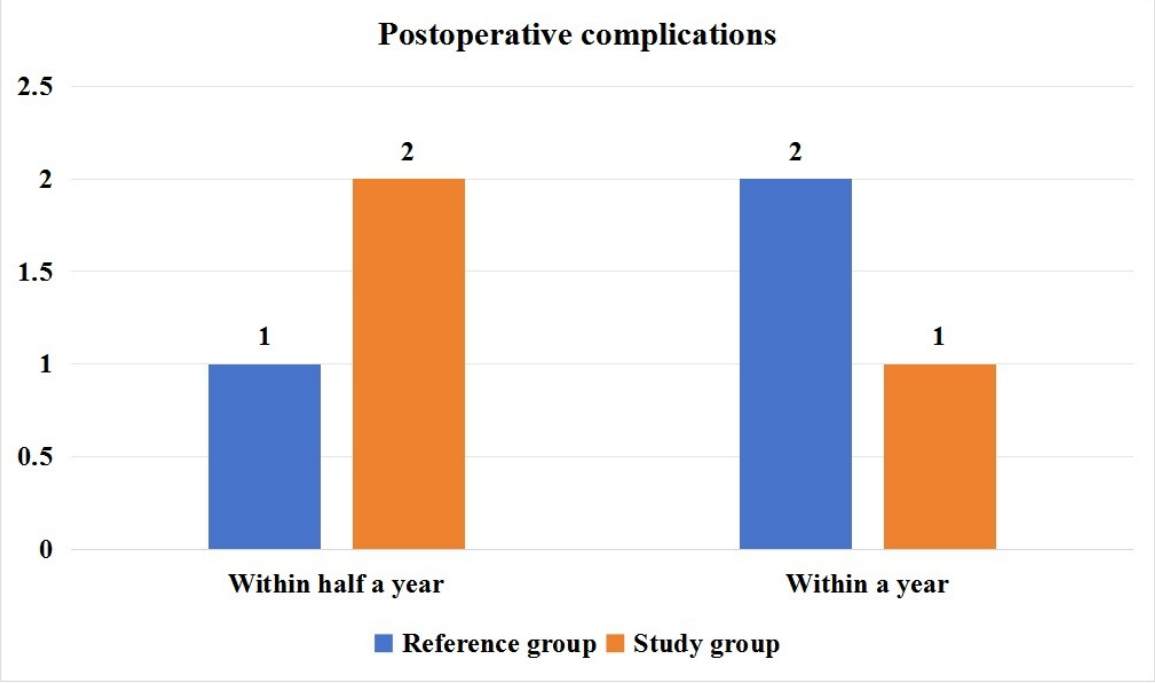

Fig. 1. Comparison of postoperative complications between the two experimental groups.

covery of elderly patients with acute appendicitis. The reasons for these outcomes are as follows.

An indwelling catheter is a routine procedure for patients undergoing general anesthesia. However, during general anesthesia, the cerebral cortex remains in an inhibitory state. It cannot accept the cognition of catheter implantation and leads to relatively poor tolerance during the anesthesia recovery period, thus affecting the postoperative recovery of patients [19]. Conversely, intraspinal anesthesia is performed by injecting anesthetic drugs into the spinal canal space, directly blocking nerve conduction to achieve the desired anesthetic effect. This approach has a simpler operation process than general anesthesia. It does not require patient consciousness, which can reduce the dosage of anesthetic drugs, avoid nerve function damage caused by excessive doses, and shorten the postoperative recovery time [20].

In this study, the levels of HR, RR, SBP, DBP, and SaO2 were higher in the study group compared to the reference group ($p < 0.001$), indicating that the intraoperative vital signs of patients in the study group were more stable. A study by Wang AY *et al.* [21] reported that intraspinal anes-

Table 6. Comparison of VAS scores between the two experimental groups [M (P_{25}, P_{75}), points].

Variables	Reference group (n = 106)	Study group (n = 103)	*z*-value	*p*-value
3 h after surgery	5.00 (4.00, 6.00)	3.00 (2.00, 4.00)	–11.480	<0.001
6 h after surgery	7.00 (6.00, 7.25)	5.00 (4.00, 6.00)	–9.284	<0.001
12 h after surgery	5.00 (4.00, 6.00)	3.00 (2.00, 4.00)	–10.910	<0.001

Note: VAS, Visual Analogue Scale.

Table 7. Comparison of postoperative recovery between the two experimental groups [M (P_{25}, P_{75})].

Variables	Reference group (n = 106)	Study group (n = 103)	*z*-value	*p*-value
Recovery time of intestinal peristalsis (h)	8.60 (7.70, 9.30)	7.70 (7.00, 8.40)	–5.923	<0.001
Anal exsufflation time (h)	24.40 (22.83, 25.70)	21.10 (19.50, 22.80)	–9.054	<0.001
Out-of-bed time (h)	17.50 (16.30, 18.50)	15.80 (14.80, 16.80)	–7.099	<0.001

thesia is a safe and effective alternative to general anesthesia, particularly beneficial for high-risk patients, including the elderly with complications and frail individuals. Intraspinal anesthesia appears to be an effective method in lumbar and thoracolumbar surgery, offering many benefits such as safe operation [22, 23]. The findings of Ai WF [24] showed that the levels of SBP, DBP, and HR were lower in the intraspinal anesthesia group than in the general anesthesia group. Another study indicated that intraspinal anesthesia can ensure the stability of HR, blood pressure, and other indicators in puerpera, with high application value [25]. Furthermore, we found that hospitalization costs, discharge time, and postoperative recovery indicators (time of intestinal peristalsis recovery, anal exsufflation time, and out-of-bed time) were lower in the study group compared to the reference group. A study by El Moheb M *et al*. [26] demonstrated that compared to general anesthesia, intraspinal anesthesia is more beneficial for the prognosis of patients undergoing appendectomy, being associated with fewer postoperative complications and shorter hospitalization time through multivariate analysis. Adverse reactions are crucial indicators for evaluating the effect of surgery and anesthesia. In this study, we observed that the study group had a lower incidence of adverse reactions compared to the reference group. A study by Erdem VM *et al*. [27] revealed that spinal anesthesia/epidural anesthesia is effective and safe for patients undergoing LA, offering benefits such as reduced postoperative pain and limited complications.

As the body gradually metabolizes anesthetic drugs, patients usually experience different degrees of postoperative pain. Effective pain control is essential for improving postoperative rehabilitation and effectively reducing postoperative pain, which is a significant clinical objective [28, 29]. In our study, the study group had lower scores at 3 h, 6 h, and 12 h after surgery compared to the reference group, suggesting that intraspinal anesthesia can significantly reduce postoperative pain. Local anesthetics effectively reduce postoperative pain, and intraspinal anesthesia contributes to minimizing the need for prescription opioid drugs. This reduced opioid requirement in appendicitis patients who receive LA treatment indicates a positive shift in postoperative pain management [30]. Compared to general anesthesia, intraspinal anesthesia leads to a lower incidence of postoperative vomiting, reduced hospitalization costs, and shorter hospitalization time without compromising surgical outcomes [31]. Intraspinal anesthesia is increasingly applied in complex patient groups. A study by Owen AR *et al*. [32] revealed that patients receiving intraspinal anesthesia, compared to those undergoing general anesthesia, had lower doses of oral morphine after surgery, lower VAS scores, and shorter hospital stays. CRP, IL-6, and TNF-α are common inflammatory markers. CRP is an acute inflammatory protein that can increase up to 1000 times at the site of infection or inflammation, serving as a sensitive systemic marker of inflammation and tissue damage [33, 34]. Moreover, IL-6 is a pleiotropic cytokine. Increased IL-6 levels lead to excessive inflammation and cytokine storm, with considerable increases observed in most inflammatory conditions [35, 36]. Furthermore, TNF-α is crucial in coordinating the inflammatory response in mammals, either by directly promoting inflammation by inducing the expression of inflammatory genes or indirectly by triggering cell death [37]. TNF-α plays a pivotal role in almost all types of inflammatory diseases [38]. Therefore, in this study, CRP, IL-6, and TNF-α levels were compared between the two experimental groups. The results showed no difference in the levels of CRP, IL-6, and TNF-α between the two groups before and after surgery. Additionally, no differences were found in the incidence of local adhesion, abscess, and intestinal obstruction between the two groups within 1 year, indicating that the two anesthesia methods have equivalent effects to some extent. However, patient tolerance should be considered to improve the safety of surgery when selecting anesthesia methods for elderly patients with appendicitis.

A study conducted by Inangil G and Cansiz KH [39] demonstrated that intraspinal anesthesia can lead to involuntary movement, which usually disrupts the posture of patients and affects the success of the procedure. Therefore, preventive measures should be taken to reduce accidental movement during skin puncture. Various factors, including technology procedures and patient-specific characteristics,

can affect the effectiveness of intraspinal anesthesia. These factors include age, gender, body mass index (BMI), complications such as cardiovascular disease, diabetes, respiratory diseases, pre-existing neurological disorders, allergies, and a history of adverse reactions to anesthetics [40]. Before implementing intraspinal anesthesia, patients' physical health should be comprehensively evaluated to improve the safety of anesthesia.

This study has some limitations. (1) Due to constraints such as time, manpower, and financial resources, the study included a limited number of study subjects, which may affect the accuracy of research results. (2) Being a single-center study, the study objects may possess specific regional characteristics, affecting the generalizability of the results. In the future, multi-center studies with large samples will be performed to improve the scientific rigor and generalizability of the findings. (3) This is a retrospective study, relying on the data extracted from the existing records and the limited observation indicators. Prospective studies will aim to present more comprehensive results and improve the scientific validity and applicability of the results.

Conclusions

In conclusion, intraspinal anesthesia is more beneficial for the postoperative recovery of elderly patients with acute appendicitis. Compared to general anesthesia, intraspinal anesthesia can reduce postoperative pain and shorten hospitalization time. Therefore, intraspinal anesthesia can be considered if the patient can tolerate this approach.

Availability of Data and Materials

Data to support the findings of this study are available on reasonable request from the corresponding author.

Author Contributions

XS, JZ and JC designed the research study; WR and YL performed the research; XS and JZ collected and analyzed the data. YL, JC and WR have been involved in drafting the manuscript and all authors have been involved in revising it critically for important intellectual content. All authors give final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

All patients provided informed consent, and the study design followed the Declaration of Helsinki (2013). This study has been approved by the ethics committee of Tianjin Hospital of Tianjin University (approval No.: 2021TJ011). All patients included in this study signed the informed consent.

Acknowledgment

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

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