Efficacy of Ropivacaine in Conjunction with Dexmedetomidine on Postoperative Pain Relief and Sleep Quality in Laparoscopic Cholecystectomy

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To look into the efficacy of ropivacaine in conjunction with dexmedetomidine on postoperative pain relief and sleep quality in individuals undergoing laparoscopic cholecystectomy. Allocated into an observation group and a control group, the study enrolled a total of 240 individuals who underwent laparoscopic cholecystectomy from January 2019 to January 2024, with 120 individuals in each group. Local infiltration analgesia with ropivacaine hydrochloride injection was administered in the incision for the control group, while the observation group received a combined local infiltration analgesia with ropivacaine hydrochloride and dexmedetomidine hydrochloride injections. Pain intensity of the incision during rest and activity at 3, 12, 24, and 48 h post-surgery was assessed using the visual analogue scale. Postoperative recovery was evaluated by comparing the first flatus time, first oral intake time, first out-of-bed time, and length of hospital stay between the two groups. The Pittsburgh sleep quality index was employed to evaluate sleep quality at both pre-treatment and post-treatment stages. The occurrence of adverse drug reactions, encompassing incision infection, nausea, vomiting, dizziness, and the cumulative prevalence of adverse reactions, was noted in both groups. The observation group exhibited lower visual analogue scale scores for incisional pain during both rest and activity at 3, 12, 24, and 48 h compared to the control group. The observation group exhibited significantly shorter durations of first flatus time, first oral intake time, first out-of-bed time, and hospital stay compared to the control group. On the 1st d after surgery, the Pittsburgh sleep quality index score was lower in the observation group, indicating an enhancement in sleep quality ($p<0.05$). The incidence of adverse reactions, including incision infection, nausea, vomiting, dizziness, did not differ significantly between the two groups ($p>0.05$). To summarize, the results of this research indicate that the concurrent administration of ropivacaine and dexmedetomidine offers advantages in enhancing postoperative pain relief and sleep quality for individuals undergoing laparoscopic cholecystectomy. These findings lend support to the potential utilization of this combination approach in clinical practice.

Key words: Ropivacaine, dexmedetomidine, laparoscopic cholecystectomy, pain relief, sleep quality

Widely employed in clinical practice, Laparoscopic Cholecystectomy (LC) is a commonly performed surgical procedure for the management of gallstones[1,2]. Nonetheless, postoperative pain is a frequently encountered complication of this surgical procedure, exerting considerable influence on patient's postoperative recovery and life quality[3,4]. Hence, it is imperative to implement effective pain management strategies to enhance patient's postoperative recovery and satisfaction. Currently, the commonly used medications for pain management include opioid analgesics (such as morphine) and non-opioid medications (including non-steroidal anti-inflammatory drugs and local anesthetics). However, opioids have certain limitations in postoperative pain management, such as potential addiction risks, respiratory depression, and postoperative nausea[5,6]. Therefore, the search for alternative analgesic medications and approaches is a current research focus. Ropivacaine is a local anesthetic that has been shown to have good analgesic effects

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and safety[7,8]. Dexmedetomidine, as one of the commonly used drugs in the perioperative period, not only provides stable sedation, analgesia, and hypnotic effects[9,10], but also exhibits certain immune functions, such as reducing cytokine secretion, decreasing white blood cell count, stabilizing C-reactive protein levels, and promoting cytokine balance in T cells[11,12]. Additionally, research has found that dexmedetomidine enhances the analgesic and sedative effects of ropivacaine[13,14]. The utilization of combined ropivacaine and dexmedetomidine for postoperative pain management following LC has garnered interest among researchers. Furthermore, the sleep quality of patients undergoing LC is also affected to a certain extent. Postoperative pain and discomfort can lead to a decline in sleep quality, further affecting patient's quality of life and recovery process[15]. Hence, investigating the impact of combined ropivacaine and dexmedetomidine on postoperative pain relief and sleep quality in individuals undergoing LC holds clinical significance by enhancing postoperative pain management and enhancing patient satisfaction. To summarize, this research seeks to ascertain the effects of combined ropivacaine and dexmedetomidine on postoperative pain relief and sleep quality in individuals undergoing LC. This study's findings will serve as a valuable resource for formulating effective postoperative pain management strategies, ultimately promoting patient recovery and improving their quality of life. For this research, 240 individuals who underwent LC in a particular hospital from January 2019 to January 2024 were chosen to participate. They were randomly assigned to two groups, namely the observation group and the control group, with 120 patients in each group. Regarding the observation group, it comprised 56 males and 64 females, with ages ranging from 36 y to 59 y and an average age of (49.46±7.72) y. The average Body Mass Index (BMI) of this group was (22.69±3.78) kg/m^2. In contrast, the control group consisted of 61 males and 59 females, aged between 37 y and 61 y, with an average age of (49.16±8.13) y. The average BMI of the control group was (22.35±3.74) kg/m^2. The general data showed no statistically remarkable disparities between groups, confirming their comparability ($p>0.05$). Approval for conducting this research was granted by the hospital's ethics committee, ensuring adherence to ethical principles. All patients were fully informed and willingly participated in the study, as indicated by their signed consent forms. In accordance with the minimally invasive treatment guidelines for hepatobiliary stones developed by the surgical branch of the Chinese medical association[16]. Participants who were subjected to general anesthesia and underwent the procedure of LC; individuals with an anesthesia grading of I-II according to the American Society of Anesthesiologists (ASA) classification and individuals without surgical contraindications. Patients aged 18 y to 75 y were included in this study. Participants with a history of gastrointestinal ulcers; individuals with bleeding tendencies; subjects with a history of abdominal surgery; patients with concomitant tumor diseases or severe liver and kidney dysfunction; patients unable to effectively communicate due to mental abnormalities or dementia and patients who are pregnant or breastfeeding, etc., were excluded. Both groups of individuals underwent routine fasting and were prohibited from drinking before surgery. They received general anesthesia and underwent LC. Anesthesia induction included intravenous injection of fentanyl citrate injection (manufactured by China National Pharmaceutical Group Industrial Co., Ltd. Langfang Branch, approval number H20123298, specification 10 ml:0.5 mg (calculated as fentanyl)) at a dose of 2-4 μg/kg, etomidate injection (manufactured by Jiangsu Enhua Pharmaceutical Co., Ltd., approval number H32022992, specification 10 ml:20 mg) in quantities of 0.2 mg/kg of body weight, and cisatracurium besylate injection (manufactured by Hangzhou Ausia Biotech Co., Ltd., approval number H20213438, specification 5 ml:10 mg (calculated as cisatracurium besylate)) in quantities of 0.2 mg/kg of body weight. During the procedure, endotracheal intubation and mechanical ventilation were utilized, involving a tidal volume ranging from 6 to 10 ml/kg, a respiratory rate of 12 to 18 breaths per minute, an Inspiration-to-Expiration (I:E) ratio of 1:2, an oxygen flow rate of 2 l/min, and maintenance of an end-tidal carbon dioxide partial pressure between 35 and 45 mmHg. During surgery, propofol emulsion injection (manufactured by Xi'an Lipbang Pharmaceutical Co., Ltd., approval number H20123318, specification 50 ml:1.0 g) was given in quantities of 4-6 mg/kg of

body weight, and remifentanil hydrochloride injection (manufactured by China National Pharmaceutical Group Industrial Co., Ltd. Langfang Branch, approval number H20123421, specification 2 mg (calculated as remifentanil $C_{20}H_{28}N_2O_5$)) was administered at a dose of 5-10 μg/kg/h *via* continuous intravenous infusion. Intermittent administration of cisatracurium besylate injection was used to maintain muscle relaxation. No preemptive analgesia or preventive analgesic interventions were performed in either group before surgery. Postoperatively, the observation group received local infiltration analgesia with ropivacaine hydrochloride injection (manufactured by Chengdu Tiantaishan Pharmaceutical Co., Ltd., approval number H20052666, specification 75 mg (calculated as ropivacaine hydrochloride)) combined with 1 μg/kg dexmedetomidine hydrochloride injection (manufactured by Jiangsu Hengrui Medicine Co., Ltd., approval number H20090248, specification 2 ml:200 μg (calculated as dexmedetomidine)) (within 20 ml) for local analgesia. The control group received local infiltration analgesia with ropivacaine hydrochloride injection. Visual Analogue Scale (VAS) scores were used to evaluate the pain intensity of the incision at 3, 12, 24, and 48 h after surgery during rest and activity. Pain severity was assessed using a 10 cm scale ruler known as the VAS[17]. In this scale, scores ranged from 0 to 10, where higher scores corresponded to more intense pain. Postoperative recovery was assessed by comparing the first flatus time, first oral intake time, first out-of-bed time, and length of hospital stay between the two groups. Utilizing the Pittsburgh Sleep Quality Index (PSQI)[18], developed by Buysse, sleep quality was assessed both before and after treatment. Comprising seven dimensions, including sleep efficiency and subjective sleep quality, the PSQI employs a 3-level scoring system. Sleep quality is represented by scores on the PSQI, which range from 0 to 21 points, with higher scores reflecting diminished sleep quality. The occurrence of adverse drug reactions, including incision infection, nausea, vomiting, dizziness, and the total incidence of adverse reactions, was recorded in both groups. Statistical Package for the Social Sciences (SPSS) 25.0 will be employed to perform the statistical analysis in this research. Mean and standard deviation will be reported for continuous variables and analyzed through t-tests, while frequencies and percentages (n %) will be used to represent categorical variables and assessed using Chi-square (χ^2) tests. The significance level of $p<0.05$ will be applied to determine statistical significance. In both resting and active states, the observation group exhibited lower VAS scores for incisional pain than the control group at 3, 12, 24, and 48 h following the operation ($p<0.05$) as shown in Table 1. The durations for the first flatus time, first oral intake time, first out-of-bed time, and length of postoperative hospital stay were notably reduced in the observation group as opposed to the control group, as indicated by Table 2 ($p<0.05$). The PSQI score exhibited no notable disparity between the two groups during the admission period ($p>0.05$). However, after treatment, both groups showed a remarkable decline in PSQI scores. Notably, the improvement was more prominent in the observation group, displaying a considerable difference ($p<0.05$) as shown in Table 3. No remarkable difference was found in the frequency of incision infection, nausea, vomiting, dizziness, and other adverse reactions between the groups ($p>0.05$) as shown in Table 4. This research sought to determine the impact of combined ropivacaine and dexmedetomidine on postoperative pain relief and sleep quality in individuals undergoing LC. As per the findings, the observation group demonstrated remarkably lower VAS scores for incision pain than the control group at 3, 12, 24, and 48 h during both rest and activity ($p<0.05$). Additionally, the observation group exhibited expedited recovery in terms of the first flatus time, first oral intake time, first out-of-bed time, and duration of hospital stay ($p<0.05$). Both groups exhibited considerable improvement in sleep quality after treatment; however, the observation group demonstrated a more substantial improvement, with a statistically remarkable difference ($p<0.05$). Moreover, no statistically notable difference in the occurrence of adverse reactions, such as incision infection, nausea, vomiting, and dizziness, between the two groups was observed ($p>0.05$). In light of the results, the combined administration of ropivacaine and dexmedetomidine demonstrates a beneficial analgesic effect in individuals undergoing LC. The observation group showed lower incision pain levels in the early (3 h) and extended (48 h) postoperative periods, suggesting that the

combination of ropivacaine and dexmedetomidine provides more effective analgesia. Moreover, the observation group demonstrated faster recovery in terms of the first flatus time, first oral intake time, first out-of-bed time, and length of postoperative hospital stay, which may be attributed to the enhanced analgesic effect of combined ropivacaine and dexmedetomidine, promoting postoperative recovery. Furthermore, both groups exhibited enhanced sleep quality on the initial day following the surgical procedure, with a more notable improvement observed in the observation group. This suggests a potential positive impact of the combination of ropivacaine and dexmedetomidine on sleep quality. However, additional research is required to assess the prolonged effects on sleep quality. Importantly, the incidence of adverse reactions such as incision infection, nausea, vomiting, and dizziness did not differ remarkably between the two groups, suggesting that the application of combined ropivacaine and dexmedetomidine did not increase safety risks compared to ropivacaine alone. Although this research assessed the effects of combined ropivacaine and dexmedetomidine on postoperative pain relief and sleep quality after LC, it is important to acknowledge the limitations. Firstly, despite adopting a randomized controlled trial design, potential biases and random errors cannot be completely excluded. Although efforts were made to ensure the comparability of baseline characteristics between the two groups, there may still be unrecorded factors affecting the research results. Secondly, the observational period of this research was relatively short, only lasting for 48 h, which may limit the information on long-term analgesic effects and sleep quality. More extensive evaluation of the sustained effects and adverse reactions of combined ropivacaine and dexmedetomidine may be achieved through subsequent long-term follow-up studies. Overall, the outcomes of this study demonstrate the favorable analgesic effects and improvement in sleep quality associated with the combined use of ropivacaine and dexmedetomidine in patients undergoing LC.

TABLE 1: VAS SCORE

	Group	3 h after operation	12 h after operation	24 h after operation	48 h after operation
Resting state	Observation	2.68±1.30	2.47±1.08	1.97±0.85	1.51±0.50
	Control	4.81±1.51	4.23±1.32	2.98±1.25	2.18±0.73
	t	11.748	11.361	7.369	8.247
	p	0.000	0.000	0.000	0.000
Active state	Observation	2.93±1.38	2.74±1.25	2.08±0.98	1.83±0.71
	Control	5.46±1.68	4.88±1.44	3.48±1.26	2.54±0.93
	t	12.736	12.235	9.609	6.706
	p	0.000	0.000	0.000	0.000

TABLE 2: POSTOPERATIVE RECOVERY

Group (n=120)	First flatus time (h)	First oral intake time (d)	First out-of-bed time (d)	Postoperative hospital stay (d)
Observation	23.73±6.87	3.57±1.40	1.78±0.65	7.32±1.02
Control	37.63±7.35	5.38±2.36	2.65±0.86	9.64±1.71
χ^2	15.130	7.245	8.770	12.794
p	0.000	0.000	0.000	0.000

TABLE 3: PSQI SCORE

Group (n=120)	PSQI		t	p
	Before	After		
Observation	11.25±2.59	6.18±1.28	19.257	0.000
Control	11.50±2.55	10.52±2.52	3.004	0.003
t	0.753	16.839	-	-
p	0.452	0.000	-	-

TABLE 4 ADVERSE REACTIONS (n %)

Group (n=120)	Dizzy	Nausea	Vomiting	Incision infection	Overall incidence
Observation	4 (3.33)	1 (0.83)	2 (1.67)	1 (0.83)	8 (6.67)
Control	3 (2.50)	3 (2.50)	2 (1.67)	2 (1.67)	10 (8.33)
χ^2			0.240		
p			0.624		

Conflict of interests:

The authors declared no conflict of interests.

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