

ORIGINAL RESEARCH



Effects of dexmedetomidine combined with ropivacaine on the treatment of lumbar plexus sciatic nerve block in elderly patients with lower limb fractures

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Abstract

To further explore the effects of dexmedetomidine combined with ropivacaine in the treatment of lumbar plexus sciatic nerve block in elderly patients with lower limb fractures. 98 patients with lower limb fractures enrolled from January 2020 to January 2022 were randomly divided into the study and control groups, with 49 cases in each group. The study group received dexmedetomidine combined with ropivacaine for nerve block; while the control group received ropivacaine for nerve block. The anesthesia effect (duration time of onset and duration time of sensory block and motor block), heart rate, blood pressure, pain score, and adverse effects were compared between the study and control groups. Patients in the study group given dexmedetomidine combined with ropivacaine for lumbar plexus sciatic nerve block had a longer duration time of sensory block and motor block than the control group, showing a better anesthetic effect. The levels of mean arterial blood pressure (MAP) and heart rate (HR) in the study group at T1, T2, T3, T4, and T5 were significantly lower than that in the control group. The pain scores of the study group was lower than that of the control group, indicating the effects of dexmedetomidine combined with ropivacaine on reducing pain. Besides, the study group showed an adverse reaction incidence of 4.08%, which was slightly higher than that of the control group, with an index of 2.04%, without statistically significant difference. Dexmedetomidine combined with ropivacaine can enhance the effect of ropivacaine block, improve the heart rate index, and reduce patients' pain, which is one of the reliable schemes in clinical practice for lumbar plexus sciatic nerve block.

Keywords

Dexmedetomidine; Ropivacaine; Lumbar plexus sciatic nerve block; Lower limb fracture in the elderly

1. Introduction

Clinical case studies have demonstrated that severe trauma with high-energy shock is the primary initial cause of lower extremity fractures in patients [1, 2]. As the aging process of our society intensifies, the effects of low energy may cause osteoporotic elderly people to suffer lower limb fractures. Therefore, the incidence of lower extremity fractures in the elderly population shows a tendency to rise. Currently, surgery is an effective treatment for lower limb fractures in the elderly. However, the safety and effectiveness of clinical anesthesia during surgery are also considered [3]. According to clinical research [4, 5], the use of nerve blocks is more effective than other anesthetic modalities. However, the postoperative analgesic effect needs to be further improved due to the characteristics of local anesthetic drugs. Therefore, how to effectively prolong the effect of local anesthetic drugs has become one of the focal issues of clinical research. At present,

studies have indicated [6–8] dexmedetomidine to show certain advantages in enhancing the effects of nerve block. Therefore, 98 patients with lower limb fractures who were clinically admitted to Deyang People's Hospital between January 2020 and January 2022 we enrolled to investigate the effects of dexmedetomidine combined with ropivacaine on the treatment of lumbar plexus sciatic nerve block in elderly patients with lower limb fractures during surgery.

2. Materials and Methods

2.1 Clinical Data

A total of 98 patients with lower extremity fractures from Deyang People's Hospital between January 2020 and January 2022 were enrolled. Patients were divided into the study and control groups, with 49 patients in each group. The study group includes 29 males and 20 females, aged 66 to 75 years, mean age (70.24 ± 2.25) years, operation time of 2–3 hours, mean

surgery time was (2.59 ± 0.45) hours, body mass index of 21–23 kg/m², mean body mass index (22.14 ± 0.54) kg/m². The American Society of Anaesthesiologists' (ASA) grading in the study group included 12 grade I and 37 grade II patients. In the control group, there were 30 males and 19 females, aged 64 to 75 years, with an average age of (70.29 ± 2.14) years, operation time of 2–4 hours, with an average surgery time of (2.67 ± 0.53) hours, body mass index of 20–23 kg/m², mean body mass index (22.18 ± 0.57) kg/m². The ASA grading in the control group included 14 grade I and 35 grade II patients.

There was no significant difference in clinical data between the study and control groups.

(1) Inclusion criteria: all obtained clinical indications for surgery related to lower limb fracture; the duration of the surgery was less than 4 hours; all signed the informed consent form.

(2) Exclusion criteria: allergic to α -2 agonists and other drugs used during surgery; patients with hypertension; patients with peripheral vascular disease; patients with unstable preoperative hemodynamic index.

2.2 Anesthesia method

(1) Selecting the puncture site

Lumbar plexus block: Keep the patient in a lateral position with the body arched. Make two vertical parallel lines on the plane of the lumbar 4th spines and select the junction point of the vertical 1/3 between the two parallel lines as the puncture point.

Sciatic nerve block: A vertical line was drawn at the midpoint of the line connecting the greater trochanter of the femur and the posterior superior iliac crest, with the focal point at the intersection of this vertical line and the line connecting the two sacral fissures as the puncture point.

(2) Position and Puncture

The patient was given an ultrasound combined with neurostimulation to guide positioning, and the relevant parameters were set as follows: Frequency: 1 Hz; Intensity: 1 mA; Pulse: 0.1 ms. Pay attention to the patient's muscle twitches during puncture process to ensure accurate positioning. After the needle was entered and the blood was withdrawn, the relevant drugs were injected at an even rate. All of the above operations were performed by the same experienced associate physician.

(3) Drug injection

Patients in the study group were given dexmedetomidine (Approval No. H20183220; Yangzijiang Pharmaceutical Group Ltd. Company, Jiangsu Province, China; Specification: 1 mL: 0.1 mg) 1 μ g/kg + ropivacaine hydrochloride injection 20 mL + saline, a total of 40 mL mixture.

Patients in the control group were given ropivacaine hydrochloride injection (Approval No. H20113463; Hebei Yipin Pharmaceutical Ltd. Company, Hebei Province, China; Specification: 10 mL: 75 mg) 20 mL + saline 20 mL.

Both groups were given 25 mL of drug mixture by lumbar plexus block or 15 mL of drug mixture by sciatic nerve block.

2.3 Observed indicators

The anesthesia effects (onset time and duration time of sensory block and motor block), heart rate (HR), mean arterial blood

pressure (MAP), pain scores, and adverse reactions at different time points (before the nerve block (T0) and 5 min (T1), 15 min (T2), 45 min (T3), 60 min (T4), and 90 min (T5) after the nerve block) were measured and compared between the study and control groups. A visual analog scale (VAS) with a score range of 0 to 10 was used to evaluate pain, with higher scores indicating more severe pain.

2.4 Statistical analysis

All data were statistically analyzed using SPSS (22.0, IBM company, Chicago, USA). Measurement data and count data were reported as $\bar{x} \pm s$ and %, respectively. Significant differences were determined using Student's *t*-test, ANOVA, and χ^2 test. $p \leq 0.05$ was regarded as statistically significant.

3. Results

3.1 Comparison of anesthetic effects between the study and control groups

As shown in Table 1, the duration time of both sensory block and motor block was longer in the study group than that in the control group, and differences were significant (all $p < 0.05$). However, the effect time of both sensory block and motor block in the study group and control group showed no significant difference ($p > 0.05$).

3.2 Comparison of heart rate and blood pressure indexes between the study and control groups at different time points

As shown in Table 2, the mean arterial blood pressure (MAP) and heart rate (HR) of the study and control groups at different times (T0, T1, T2, T3, T4, and T5) was compared after nerve block. The results revealed that the levels of MAP and HR in the study group at T1, T2, T3, T4, and T5 were lower than that in the control group, with all differences statistically significant ($p < 0.05$). However, the levels of MAP and HR in the study and control groups at T0 showed no significant difference.

3.3 Comparison of pain scores between the study and control groups at different time points

The pain scores of the study and control groups at awakening, 6 h, 12 h, and 24 h postoperative time points were compared, and the results showed that the pain scores of the study group was lower than that of the control group, and all the differences were statistically significant ($p < 0.05$) (Table 3).

3.4 Comparison of the occurrence of adverse reactions in the study and control groups

As shown in Table 4, the study group showed an adverse reaction incidence of 4.08%, which was slightly higher than that of the control group, with an index of 2.04%, without statistically significant difference.

TABLE 1. Comparison of anesthetic effects between the study and control groups ($\bar{x} \pm s$).

Group	N	Sensory block (min)		Motor block (min)	
		Effective time	Duration time	Effective time	Duration time
Study group	49	10.10 \pm 1.12	665.35 \pm 62.15	15.12 \pm 1.64	640.53 \pm 63.15
Control group	49	9.90 \pm 1.10	467.24 \pm 45.16	14.92 \pm 1.51	558.35 \pm 5.54
<i>t</i> value	—	0.89	18.05	0.63	9.07
<i>p</i> value	—	0.375	0.000	0.532	0.000

TABLE 2. Comparison of heart rate and blood pressure indexes between the study and control groups of patients at different time points ($\bar{x} \pm s$).

Indicators	Group	N	T0	T1	T2	T3	T4	T5	F value	<i>p</i> value
MAP/mmHg										
	Study group	49	98.24 \pm 9.44	98.10 \pm 9.09	90.24 \pm 8.91	94.35 \pm 9.62	86.35 \pm 8.26	85.96 \pm 8.15	18.798	0.000
	Control group	49	96.45 \pm 9.64	98.22 \pm 9.13	98.98 \pm 8.53	95.04 \pm 9.45	86.43 \pm 8.14	86.18 \pm 8.21	20.796	0.000
HR/(times/min)										
	Study group	49	86.24 \pm 8.15	82.35 \pm 9.16	79.16 \pm 8.15	74.16 \pm 7.24	72.16 \pm 8.10	75.98 \pm 6.94	21.558	0.000
	Control group	49	86.20 \pm 7.13	92.65 \pm 9.13*	96.18 \pm 9.65*	95.82 \pm 9.16*	95.67 \pm 9.33*	95.67 \pm 8.97*	9.305	0.000

*Compared with the control group, with a significantly different ($p < 0.05$). MAP: mean arterial blood pressure; HR: heart rate.

TABLE 3. Comparison of pain scores between the study and control groups at different time points ($\bar{x} \pm s$), points).

Groups	N	Awakening time	Postoperative 6 h	Postoperative 12 h	Postoperative 24 h	F value	<i>p</i> value
Study group	49	2.80 \pm 0.40	1.55 \pm 0.50	1.98 \pm 0.14	1.11 \pm 0.40	172.49	0.000
Control group	49	7.16 \pm 0.37	4.24 \pm 0.40	3.35 \pm 0.50	1.65 \pm 0.50	1307.50	0.000
<i>t</i> value	—	56.01	29.41	18.47	5.90		
<i>p</i> value	—	0.000	0.000	0.000	0.000		

TABLE 4. Comparison of the occurrence of adverse reactions in the study and control groups (n, %).

Groups	N	Bradycardia	Respiratory depression	Nausea and vomiting	Total adverse reactions
Study group	49	1 (2.04)	0 (0.00)	1 (2.04)	2 (4.08)
Control group	49	0 (0.00)	1 (2.04)	1 (2.04)	1 (2.04)
χ^2 value	—		—		0.34
<i>p</i> value	—		—		0.558

4. Discussion

According to clinical studies [9], older patients with lower extremity fractures commonly have multiple underlying diseases, and surgical treatment involves the administration of a substantial amount of narcotic analgesics. The elderly is more sensitive to narcotic analgesics and have lower levels of drug metabolism due to declined physiological functions. Furthermore, elderly patients with lower extremity fractures are at increased risk of anesthesia during surgical treatment and are susceptible to adverse responses associated with the

accumulation of anesthetic analgesic medications. Therefore, clinical practice should study safe and efficient anesthetic methods in elderly patients with lower limb fractures.

Clinical studies have shown that [10, 11] the use of lumbar plexus sciatic nerve block anesthesia in surgery for lower limb fractures in older patients successfully reduces the impacts on the patient's internal circulation and produce significant analgesic effects [12, 13]. Compared with other anesthetic techniques, particularly general anesthesia and intravertebral anesthesia, the risk of unfavorable clinical reactions can be successfully controlled [14, 15].

Dexmedetomidine has gradually gained widespread recognition and utilization as an adjunct to local anesthetics in clinical practice [16, 17]. However, most clinical studies have been conducted on practices related to upper extremity brachial plexus nerve blocks, and not many clinical studies have been conducted on lower extremity-related surgeries. The results of similar animal experiments found [18–20] that a certain concentration of dexmedetomidine can produce a certain control effect on the amplitude of the action potential of peripheral nerve complex, thereby reducing it, and can produce targeted inhibitory effect on the cationic current after hyperexcitation activation, thereby achieving the purpose of prolonging the action of ropivacaine. In addition, dexmedetomidine is a α -2 agonist that has significant anxiolytic and peripheral analgesic effects as an adjunct to general or regional anesthesia and is widely used in surgical practice due to its excellent safety and reliability properties [21–24].

The present study indicated that, patients in the study group given dexmedetomidine combined with ropivacaine for lumbar plexus sciatic nerve block had a longer duration time of sensory block and motor block than the control group, showing a better anesthetic effect. The levels of MAP and HR in the study group at T1, T2, T3, T4, and T5 were significantly lower than that in the control group. The pain scores of the study group was lower than that of the control group, indicating the effects of dexmedetomidine combined with ropivacaine on reducing pain. Besides, the study group showed an adverse reaction incidence of 4.08%, which was slightly higher than that of the control group, with an index of 2.04%, without statistically significant difference. The adverse reactions in both groups were mainly bradycardia ($n = 1$), respiratory depression ($n = 1$) and nausea and vomiting ($n = 1$), all of which were mild, and all recovered after symptomatic treatment. These findings indicated that dexmedetomidine combined with ropivacaine for lumbar plexus sciatic nerve block could prolong the effect of ropivacaine, which were consistent with previously described studies about treatment in the upper limb pertinent surgery studies [25–27].

Further analysis [28, 29] revealed that compared with other medicines, the analgesic and sedative mechanisms of action of dexmedetomidine is the result of a multifactorial and comprehensive synergy, as well as a certain specificity. In the periphery system, dexmedetomidine exerts affects mainly by decreasing the release of norepinephrine, which in turn inhibits the activity of nerve fibers and reduces the number of action potentials. Meanwhile, it plays a role in the central system mainly by suppressing the release of locus coeruleus, substance P, thereby affecting α -2 adrenergic receptors. Clinical studies have indicated that [30] for the enhancement of ropivacaine efficacy, dexmedetomidine is not strongly associated with these central and peripheral systemic effects. Instead, it may be associated with the blocking effect of ropivacaine on the processed hyperpolarized cationic current [31–33].

5. Conclusions

In this study, the number of clinical cases was limited. Therefore, the inclusion of participants in the study was limited, mainly in older patients. In future clinical studies, the scope

of the study population should be further expanded, and the clinical effects of dexmedetomidine combined with ropivacaine lumbar plexus sciatic nerve block need to be verified in a wider range of applications. In conclusion, dexmedetomidine combined with ropivacaine in the treatment of lumbar plexus sciatic nerve block could effectively enhance the block efficacy of ropivacaine, improve heart rate indicators and pain scores, which is one of the ideal anesthetic strategies for clinical application in elderly patients undergoing lower extremity fracture surgery.

AVAILABILITY OF DATA AND MATERIALS

The authors declare that all data supporting the findings of this study are available within the paper and any raw data can be obtained from the corresponding author upon request.

AUTHOR CONTRIBUTIONS

WJ, XZ—designed the research study. WJ, SY, AX, OL, FJ—performed the research. WJ, SY, AX, OL, FJ—analyzed the data. WJ and XZ—wrote the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Ethics Committee of People’s Hospital of Deyang City (Approval no. 2019-04-009-K01). Written informed consent was obtained from a legally authorized representative(s) for anonymized patient information to be published in this article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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