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ABOUT COVER

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ORIGINAL ARTICLE

Retrospective Study

Clinical effect of ultrasound-guided nerve block and dexmedetomidine anesthesia on lower extremity operative fracture reduction

Cheng-Bin Ao, Ping-Lei Wu, Liang Shao, Jian-Ying Yu, Wei-Guo Wu

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Abstract

BACKGROUND

Lower extremity fractures are mainly treated by surgical reduction, but this operation is often affected by the patient's level of agitation and the type of anesthesia used. The main treatment for lower-extremity fractures is operative reduction. However, operations can often be affected by both agitation and the degree of anesthesia. Therefore, it is of great importance to develop an effective anesthesia program to effectively ensure the progress of surgery.

AIM

To discuss the effect of ultrasound-guided nerve block combined with dexmedetomidine anesthesia in lower extremity fracture surgery.

METHODS

A total of 120 hospital patients with lower extremity fractures were selected for this retrospective study and divided into an observation group (n = 60) and a control group (n = 60) according to the anesthesia scheme; the control group received ultrasound-guided nerve block; the observation group was treated with dextromethomidine on the basis of the control group, and the mean arterial pressure, heart rate (HR), and blood oxygen saturation were observed in the two groups.

RESULTS

The mean arterial pressure of T1, T2 and T3 in the observation group were 94.40 ± 7.10, 90.84 ± 7.21 and 91.03 ± 6.84 mmHg, significantly higher than that of the control group (P < 0.05). The observation group's HR at T1 was 76.60 ± 7.52

times/min, significantly lower than that of the control group ($P < 0.05$); The observation group's HR at T2 and T3 was 75.40 ± 8.03 times/min and 76.64 ± 7.11 times/min, significantly higher than that of the control group ($P < 0.05$). The observation group's visual analog score at 2 h, 6 h and 12 h after operation was 3.55 ± 0.87, 2.84 ± 0.65 and 2.05 ± 0.40. the recovery time was 15.51 ± 4.21 min, significantly lower than that of the control group ($P < 0.05$). Six hours post-anesthesia, epinephrine and norepinephrine in the observation group were 81. 10 ± 21.19 pg/mL and 510. 20 ± 98.27 pg/mL, significantly lower than that of the control group ($P < 0.05$), and the mini-mental state exam score of the observation group was 25. 51 ± 1.15, significantly higher than that in the control group ($P < 0.05$).

CONCLUSION

Ultrasound-guided nerve block combined with dexmedetomidine has a good anesthetic effect in the operation of lower limb fractures and has little effect on the hemodynamics of patients.

Key Words: Ultrasound; Nerve block; Dexmedetomidine; Lower extremity fracture; Anesthesia effect

Core Tip: Ultrasound-guided nerve block is the main anesthetic method for surgical bone fracture reduction. This study found that the ultrasound-guided nerve block combined with dexmedetomidine has a good anesthetic effect during the operative reduction of lower limb fractures and has little effect on the hemodynamics of patients.

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INTRODUCTION

Due to increased age and loss of bone elements, the middle-aged and elderly have a higher probability of bone fracture. This is especially true for lower extremity fractures, which have become common and have a considerable effect on quality of life of patients[1,2]. The main treatment for lower-extremity fractures is operative reduction. However, operations can often be affected by both agitation and the degree of anesthesia. Therefore, it is of great importance to develop an effective anesthesia program to effectively ensure the progress of surgery[3].

Ultrasound-guided nerve block is the main anesthetic method for surgical bone fracture reduction. Ultrasound guidance can clarify the paths of puncture tip and drug diffusion more clearly, which not only ensures anesthesia effect, but also helps to avoid unnecessary injury[4,5]. However, according to previous studies[6,7], nerve block anesthesia may lead to an incomplete block; therefore, it is often combined with additional anesthetic drugs to improve the anesthetic effect. Dexmedetomidine is a clinically effective sedative and analgesic narcotic that exerts anesthetic effects by inhibiting α2 adrenergic receptors through antisympathetic action. However, there are few clinical studies on the combined application of ultrasound-guided nerve block and dexmedetomidine, and further analysis is needed[8-10]. In our study, ultrasound-guided nerve block was used in combination with dexmedetomidine to explore the possibility of improved anesthetic effects in lower extremity fracture surgery.

MATERIALS AND METHODS

Baseline data

A total of 120 patients admitted to our hospital with lower extremity fractures from January 2017 to December 2019 were selected. The inclusion criteria were as follows: (1) patients with unilateral lower extremity fracture; (2) patients ≥ 18 years of age; and (3) patients with fully intact clinical data. The exclusion criteria were as follows: (1) patients with abnormal coagulation function, endocrine diseases, and other conditions affecting hemodynamics; and (2) pathological fracture accompanied by osteoporosis. Patients were divided into an observation group ($n = 60$) and a control group ($n = 60$). A

comparison of baseline data between the two groups is shown in Table 1.

Anesthesia methods

The control group received an ultrasound-guided nerve block. All patients were placed in the supine position, the intermuscular position was marked, the ultrasonic probe was coated with a coupling agent, and the frequency was set at 10 Hz. The scan depth after disinfection was controlled according to the actual situation of the patient, and the lower extremity nerves were pierced with a puncture needle and injected with anesthetic. Ropivacaine suspension (0.4%) was injected intravenously with a total dose of 25 mL, at a concentration of 0.361%, until lower limb nerve was completely covered by anesthetic.

The observation group was treated with dextromethomidine based on the control group. Dexmedetomidine (Jiangsu Hausen Pharmaceutical Co., LTD., National drug approval H20120312) was intravenously pumped at a constant speed of 0.7 μg/mL, and the anesthetic was stopped 10 min before the operation.

Inspection methods

A surgical life monitor was used to observe the heart rate (HR), mean arterial pressure (MAP), and blood oxygen saturation (SpO_2) in the T1, T2, and T3 segments of the two groups, and the operation time, postoperative recovery time, complications, and visual analog score (VAS) score were recorded. Serum norepinephrine and epinephrine levels were detected using enzyme-linked immunoassay.

VAS scoring criteria was as follows: 0-1 for painless pain, 2-3 for mild pain, 4-6 for moderate pain, and 7-10 for severe pain[11].

Mini mental state examination (MMSE) scores were as follows[12,13]: The highest score was 30, the score between 27 and 30 was normal, and < 27 was cognitive dysfunction. Dementia severity grading method considered 21 points to be mild MMSE, 10-20 points as moderate MMSE, and less than or equal to 9 points as severe MMSE.

Statistical analysis

The software SPSS (V22.0, IBM Corporation, Armonk, NY, USA) was adopted. A *t*-test or χ^2 test was used to analyze the differences of indexes between groups. The inspection level was bilateral $\alpha = 0.05$.

RESULTS

Comparisons of MAP, HR and SpO_2

The MAP of T1, T2, and T3 in the observation group was significantly higher than that in the control group ($P < 0.05$), and the HR at T1 of the observation group was significantly lower than that of the control group ($P < 0.05$), and the HR at T2 and T3 in the observation group was significantly higher than that in the control group ($P < 0.05$) (Table 2).

Comparison of VAS score

The VAS score of the observation group at 2 h, 6 h and 12 h after operation was significantly lower than in the control group ($P < 0.05$) (Table 3).

Comparison of epinephrine and norepinephrine before and after operation between the two groups

Six hours after anesthesia, epinephrine and norepinephrine levels in the observation and control groups were significantly lower than those before the operation ($P < 0.05$), and epinephrine and norepinephrine levels in the observation group were significantly lower than those in the control group ($P < 0.05$). These results are shown in Table 4.

Comparison of operation time and postoperative recovery time between the two groups

The postoperative recovery time in the observation group was significantly lower than that in the control group ($P < 0.05$, Table 5).

Comparison of cognitive function between preoperative and postoperative

One day after operation, the MMSE scores in the observation group and the control group were lower than those before operation. The MMSE score in the observation group was significantly higher than that in the control group ($P < 0.05$, Table 6).

Comparison of complications between the two groups

There was no significant difference in the incidence of complications between the observation and control groups ($P > 0.05$, Table 7).

Table 1 Comparison of baseline data between the two groups, *n* (%)

Group	Cases	Male	Age (yr)	Body mass index (kg/m²)	ASA		Fracture type		
					I	II	Femoral neck	Tibiofibula	Intertrochanteric femoral
Observation group	60	36 (60.00)	57.64 ± 11.35	22.7 ± 3.11	40 (66.67)	20 (33.33)	20 (33.33)	24 (40.00)	16 (26.67)
Control group	60	42 (70.00)	58.80 ± 12.20	23.0 ± 2.95	38 (63.33)	22 (36.67)	18 (30.00)	26 (43.33)	16 (26.67)
t/χ^2 value		1.319	-0.539	-0.470	0.147		0.185		
P value		0.251	0.591	0.639	0.702		0.912		

ASA: American Society of Anesthesiologists.

Table 2 Comparison of mean arterial pressure, heart rate and blood oxygen saturation in different time periods between the two groups

Index	Cases	T0	T1	T2	T3	T4
MAP (mmHg)						
Observation group	60	92.54 ± 8.11	94.40 ± 7.10	90.84 ± 7.21	91.03 ± 6.84	90.42 ± 7.12
Control group	60	93.01 ± 7.80	86.45 ± 6.58	82.30 ± 7.15	83.39 ± 6.84	90.05 ± 6.10
t value		-0.324	6.361	6.515	6.118	0.306
P value		0.747	0.000	0.000	0.000	0.760
HR (times/min)						
Observation group	60	82.21 ± 3.82	76.60 ± 7.52	75.40 ± 8.03	76.64 ± 7.11	81.21 ± 6.64
Control group	60	82.05 ± 3.95	88.15 ± 6.94	71.03 ± 7.22	70.45 ± 6.20	83.35 ± 7.10
t value		0.226	-8.743	3.135	5.083	-1.705
P value		0.822	0.000	0.002	0.000	0.091
SpO_2 (%)						
Observation group	60	97.78 ± 1.22	97.87 ± 1.12	97.68 ± 1.20	98.00 ± 1.12	98.11 ± 1.14
Control group	60	97.03 ± 1.35	97.70 ± 1.10	97.79 ± 1.23	97.76 ± 1.22	98.03 ± 1.18
t value		3.193	0.839	-0.496	1.123	0.378
P value		0.002	0.403	0.621	0.264	0.706

MAP: Mean arterial pressure; HR: Heart rate; SpO_2: Blood oxygen saturation.

DISCUSSION

Due to loss of calcium and reduced flexibility, gerontal patients have an increasing morbidity of lower extremity fracture resulting from various events such as falls and traffic accidents each year. After operative fracture reductions, these patients require a long-term bed. Because of the decreased inability to care for themselves along with the stress response to the fracture, patients often experience anxiety, depression, and other emotional reactions, with some patients even developing sleep disorders that have a considerable impact on the recovery and prognosis of patients[14].

Ropivacaine[15] is an amide anesthetic drug, with a clinical use of nerve block anesthesia. It inhibits sodium ion conduction from nerve cells, and blocks the conduction of nerve excitation and pain sensation, causing long-term block effects[16,17]. The sciatic and lumbar plexus nerves can be clearly displayed using ultrasound guidance, thus improving the success rate of the needle puncture and nerve block, reducing the stimulation to the body, preventing damage to important blood vessels and organs, and maintaining the stability of hemodynamics. However, according to some studies[18,19], ropivacaine has drawbacks such as incomplete block and slow onset of anesthesia, and thus needs to be combined with other anesthesia drugs when applied after clinical anesthesia. Dexmedetomidine is an α2 receptor agonist and has been widely used in clinical application of regional block assisted sedation with high selectivity. The literature suggests that dexmedetomidine assisted anesthesia is more effective in

Table 3 Comparison of visual analog score between the two groups

Groups	Cases	VAS scores (points)			
		2 h after surgery	6 h after surgery	12 h after surgery	24 h after surgery
Observation group	60	3.55 ± 0.87	2.84 ± 0.65	2.05 ± 0.40	1.87 ± 0.33
Control group	60	5.84 ± 1.00	3.40 ± 0.70	2.66 ± 0.38	2.00 ± 0.41
t value		-13.383	-4.541	-8.564	-1.913
P value		0.000	0.000	0.000	0.058

VAS: Visual analog score.

Table 4 Comparison of adrenaline and Noradrenaline before and after operation between the two groups

Groups	Cases	Adrenaline (pg/ml)		Noradrenaline (pg/ml)	
		Preoperative	6 h after anesthesia	Preoperative	6 h after anesthesia
Observation group	60	104.43 ± 32.21	81.10 ± 21.19[a]	630.12 ± 102.23	510.20 ± 98.27[a]
Control group	60	108.29 ± 30.11	92.11 ± 15.53[a]	634.49 ± 101.12	572.21 ± 91.54[a]
t value		-0.678	-3.246	-0.235	-3.577
P value		0.499	0.002	0.814	0.001

[a]*P* < 0.05 *vs* preoperative.

Table 5 Comparison of operation time and postoperative recovery time between the two groups

Groups	Cases	Operation time (min)	Postoperative recovery time (min)
Observation group	60	134.15 ± 32.45	15.51 ± 4.21
Control group	60	138.84 ± 38.80	19.46 ± 3.80
t value		-0.718	-5.395
P value		0.474	0.000

Table 6 Comparison of mini mental state examination score between preoperative and postoperative

Groups	Cases	Preoperative	Postoperative 1 d
Observation group	60	28.10 ± 2.01	25.51 ± 1.15[a]
Control group	60	28.03 ± 1.82	24.12 ± 1.04[a]
t value		0.200	6.944
P value		0.842	0.000

[a]*P* < 0.05 *vs* preoperative.

improving MAP and HR in patients undergoing brachial plexus block than anesthesia without dexmedetomidine.

In our study, MAP at T1, T2, and T3 in the observation group was significantly higher than that in the control group. HR at T1 was significantly lower than that in the control group, and HR at T2 and T3 were significantly higher than those in the control group. Postoperative recovery times in the observation group were significantly lower than those of the control group, indicating that ultrasonic-guided nerve block combined with dexmedetomidine in lower extremity fracture surgery was more helpful in improving hemodynamics and promoting postoperative recovery of patients than procedures without dexmedetomidine, which was consistent with the conclusions of previous studies. Dexmedetomidine can act on α2 adrenergic receptors, inhibit sympathetic nerve excitation by activating

Table 7 Comparison of complications between the two groups, *n* (%)

Groups	Cases	Nausea and vomiting	Sleepiness	Respiratory depression	Bradycardia
Observation group	60	3 (5.00)	4 (6.67)	2 (3.33)	3 (5.00)
Control group	60	2 (3.33)	5 (8.33)	1 (1.67)	2 (3.33)
χ^2		0.000	0.000	0.000	0.000
P value		1.000	1.000	1.000	1.000

prominent posterior membrane receptors, and reduce blood pressure and HR of patients. In addition, dexmedetomidine can significantly reduce the negative emotions and discomfort that can be induced by lower extremity fracture surgery through deep sedation. It can also reduce the brain tissue damage caused by anesthesia, stabilize the hemodynamic level of patients, and promote postoperative recovery of patients.

Further comparison of postoperative VAS scores of the two groups showed that the VAS score of the observation group was significantly lower than that of the control group at 2 h, 6 h and 12 h after surgery. Epinephrine and norepinephrine levels in the observation group were also significantly lower than those in the control group at 6 h after anesthesia. The MMSE score of the observation group was significantly higher than that of the control group 1d after the operation. Our results suggest that, in lower extremity fracture surgery, an ultrasound-guided nerve block combined with dexmedetomidine is helpful in improving the pain level of patients, inhibiting the secretion of epinephrine and norepinephrine, and improving cognitive function. A2 adrenergic receptors mainly exist in presynaptic and postsynaptic regions. The negative feedback mechanism can also regulate the release of adenosine triphosphate and norepinephrine to inhibit neuronal excitation and stop the transmission of pain signals. Meanwhile, α2 adrenergic receptors in the spinal cord can specifically bind its agonist dexmedetomidine, which can effectively exert analgesic effects, reduce the VAS score of patients, inhibit stress response, and thus improve the postoperative cognitive function of patients.

This safety study found no significant difference in the incidence of complications between the observation and control groups, verifying that in lower extremity fracture surgery, ultrasound-guided nerve block combined with dexmedetomidine did not increase the incidence of complications, and the safety is generally controllable. Meta-analyses suggested that dexmedetomidine can activate α2 adrenergic receptors in the spinal cord, block the discharge of neurons, reduce the pain-induced antisympathetic effect and unpleasant emotion, reduce the stress response during the operation cycle of patients, reduce the incidence of adverse reactions such as rapid heart rate and elevated blood pressure, and that it is safe and controllable under rational clinical administration[20-22].

Related studies[23,24] have shown that a high dose of dexmedetomidine administered during anesthesia maintenance can cause hypotension and bradycardia, which requires special clinical attention. In addition, patients with rapid intravenous infusion of dexmedetomidine are more prone to severe headache, hypertension, and other adverse symptoms. Therefore, intravenous infusion of dexmedetomidine is not recommended clinically. However, there are some limitations in this study, mainly including the small sample size and it being a single-center study. Further research with a larger sample size and across many institutions would be beneficial.

CONCLUSION

In conclusion, ultrasound-guided nerve block combined with dexmedetomidine has a good anesthetic effect during the operative reduction of lower limb fractures and has little effect on the hemodynamics of patients.

ARTICLE HIGHLIGHTS

Research background

It is of great importance to develop an effective anesthesia program to effectively ensure the progress of surgery.

Research motivation

This study developed an effective anesthesia program to effectively ensure the progress of surgery.

Research objectives

Discusses the effect of ultrasound-guided nerve block combined with dexmedetomidine anesthesia in lower extremity fracture surgery.

Research methods

A total of 120 patients admitted to our hospital with lower extremity fractures from January 2017 to December 2019 were selected. The control group received an ultrasound-guided nerve block. The observation group was treated with dextromethomidine based on the control group.

Research results

The mean arterial pressure of T1, T2 and T3 in the observation group were significantly higher than that of the control group. The observation group's heart rate (HR) times at T1 was significantly lower than that of the control group. The times of observation group's HR at T2 and T3 was significantly higher than that of the control group. The recovery time was significantly lower than that of the control group. Six hours post-anesthesia, epinephrine and norepinephrine in the observation group were significantly lower than that of the control group, and the mini-mental state exam score of the observation group was significantly higher than that in the control group.

Research conclusions

Ultrasound-guided nerve block combined with dexmedetomidine has a good anesthetic effect in the operation of lower limb fractures and has little effect on the hemodynamics of patients.

Research perspectives

We will explore the clinical effect of this method of anesthesia in other operations.

FOOTNOTES

Author contributions: Ao CB and Wu WG designed this retrospective study; Ao CB wrote the manuscript; Ao CB, Lei P, Shao L and Yu JY were responsible for sorting the data; and all authors contributed to the article and approved the submitted version.

Institutional review board statement: The study was approved by the Ethics Committee of Yuhuan City People's Hospital, Taizhou City, Zhejiang Province.

Informed consent statement: Patients were not required to give informed consent to the study because the analysis used anonymous clinical data that were obtained after each patient agreed to treatment by written consent.

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