Int J Clin Exp Med 2018;11(4):4168-4172
www.ijcem.com /ISSN:1940-5901/IJCEM0063993

Original Article

Dexmedetomidine improves continuous interscalene brachial plexus block in patients after arthroscopic rotator cuff repair

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Received August 18, 2017; Accepted December 29, 2017; Epub April 15, 2018; Published April 30, 2018

Abstract: Objective: To evaluate the efficacy of dexmedetomidine to improve continuous interscalene brachial plexus block in patients after arthroscopic rotator cuff repair. Materials and methods: 60 patients undergoing unilateral arthroscopic rotator cuff repair (aged 40 to 64 years old, 27 male and 33 female) were enrolled in this study. They were randomly divided into 2 groups (n = 30): Dexmedetomidine + ropivacaine group (group D) and ropivacaine group (group R). The formulation of analgesic pump was 0.2% ropivacaine in group R, and 0.2% ropivacaine plus 2 μg/kg dexmedetomidine in group D. The patients received general anesthesia and the catheter was placed around the interscalene brachial plexus under the guidance of ultrasound. VAS scores after surgery were recorded. The incidence of catheter-related and local anesthetic-related adverse events were recorded. Analgesic satisfaction score at 48 h after surgery was recorded. Results: The success rate of catheter block was 100% in both groups. Compared to group R, in group D VAS score at each time point decreased ($P < 0.05$), the number of patient-controlled analgesia (PCA) decreased at 48 h ($P < 0.05$), the incidence of dizziness, nausea, and vomiting decreased ($P < 0.05$). There were no significant differences in the time, patient number, and dose for the first use of tramadol in two groups after surgery ($P > 0.05$). The analgesic satisfaction score at 48 h after surgery was 90% in group D and 70% in group R ($P < 0.05$). Conclusion: Dexmedetomidine combined with ropivacaine in continuous interscalene brachial plexus block after arthroscopic rotator cuff repair achieves effective analgesic and sedative effects, and reduces the incidence of complications.

Keywords: Dexmedetomidine, interscalene plexus block, shoulder surgery, analgesia, rotator cuff repair

Introduction

Rotator cuff injury is common in people over the age of 60, and it will lead to shoulder joint dysfunction and pain. Shoulder arthroplasty repair surgery is a minimally invasive treatment method of rotator cuff injury, and has been widely used in the clinical due to several advantages such as minimal trauma, low infection rate, and quick recovery [1]. However, rotator cuff surgery has a shortcoming of severe pain after the surgery. Thus it is important to relieve postoperative pain after rotator cuff surgery.

Brachial plexus block, initially used as intraoperative analgesia, has gradually developed to postoperative analgesia and is widely used due to advantages such as smaller doses and lower incidence of adverse reactions [2]. Dexmedetomidine (DEX) is a highly selective adrenergic receptor agonist and can bind to the receptor with very high affinity. The affinity of DEX with α_2 receptor is 8 times of clonidine, and DEX has sedative, analgesic, and anxiolytic effects. Studies have shown that DEX can improve spinal local anesthesia and nerve block effects [3]. This study aimed to investigate the efficacy of DEX to improve continuous interscalene brachial plexus block in patients after arthroscopic rotator cuff repair.

Materials and methods

Patients

This study was approved by the Medical Ethics Committee of Cangzhou Central Hospital, and each patient signed an informed consent form.

60 patients undergoing unilateral arthroscopic rotator cuff repair were enrolled in this study. Their ages were between 40 and 64 years old, with 27 male and 33 female. Other features of these patients included: ASA grade I to grade II, BMI of 18-25 kg/m^2, no local anesthetic history, no serious cardiovascular, cerebrovascular disease, or diabetes with peripheral neuropathy. They also had no neurological impairment, no abnormality of coagulation function, and no infection in the puncture site. Before operation, patients were informed of the visual analogue scale (VAS). The patients were divided into two groups (n = 30) by using a random number table method: Dexmedetomidine + ropivacaine group (group D) and ropivacaine group (group R). Electrocardiogram (ECG), blood pressure (BP), and peripheral blood capillary oxygen saturation (SpO_2) of the patients were routinely monitored.

Procedures

The patients were in supine position and interscalene nerve plexus was located under the guidance of ultrasound (SonoSite S-Nerve Ultrasound System, USA). The puncture was performed with 18G 90 mm long puncture needle in a continuous peripheral nerve block catheter kit (Contiplex D, BRAUN, Germany) by an in-plane puncture method. Next, 10 ml 0.5% lidocaine (China Otsuka Pharmaceutical Co., Ltd.) was injected in the rear and top of the brachial plexus, respectively, and the catheter was inserted through the puncture needle and fixed. This was followed by connection of the analgesic pump. The brachial plexus motor movement and sensory block effect was detected within 30 min, and the patients with block failure were excluded from the study group. All anesthesia was performed by the same experienced anesthesiologist. All patients received general anesthesia by intravenous injection of 2 μg/kg fentanyl, 2 mg/kg propofol, and 0.2 mg/kg cisatracurium besylate, respectively. Mechanical ventilation was performed after the insertion of the enhanced tracheal tube. Arthroscopic surgery was performed in the beach chair position, and fentanyl and cisatracurium besylate were intermittently added if necessary. The changes of blood pressure and heart rate did not exceed 25% of the base value. At the end of the operation, 5 mg tropisetron was given intravenously.

After surgery the patients were extubated and sent to the post-anesthesia care unit (PACU). After the patients were completely awakened, patient-controlled analgesia (PCA) was connected and set at a continuous infusion of 0.5 mL with a lockout time of 15 min and a total volume of 20 mL. The formulation of the PCA pump was 0.2% ropivacaine (AstraZeneca, Sweden) in group R, and 0.2% ropivacaine plus 2 μg/kg dexmedetomidine in group D. After continuous analgesia for 48 h, the catheter was pulled out and the PCA pump was removed.

Measurements

The degree of pain was assessed using a NRS (0 point for painless, 10 points for intolerable pain) scoring system. NRS score > 4 represented moderate to severe pain. The degree of resistance was evaluated by using a catheter resistance scoring method (0 point for no resistance in the catheter, 1 point for some resistance but the catheter reaching beyond 3 cm of the tip, 2 points for some resistance and the catheter not reaching beyond the tip). Catheter resistance score > 1 represented a high catheter resistance. The incidence of adverse events such as neuroticism and vascular injury during the catheterization was recorded.

VAS scores (0~10 score: 0 score for no pain, 1-3 score for slight pain, 4-7 score for moderate pain, 8-10 score for severe pain) of resting state at 4 h (T1), 8 h (T2), 12 h (T3), 24 h (T4) and 48 h (T5) after surgery were recorded. The incidence of catheter-related adverse events and local anesthetic-related adverse events were recorded. For the patients taking tramadol, the time for the first use of tramadol, the number of patients and dose were recorded. The incidence of postoperative adverse events such as dizziness, nausea and vomiting, skin itching and respiratory depression was recorded. The analgesic satisfaction score at 48 h after surgery were recorded (9-10 for very satisfied, 6-8 for satisfied, 4-5 for neutral, < 3 for not satisfied).

Statistical analysis

SPSS13.0 software was used for statistical analysis, the data were expressed as mean ± standard deviation and analyzed using single factor analysis of variance. The comparison between groups was analyzed using a t-test. $P < 0.05$ was considered statistically significant.

Table 1. Comparison of patient information in two groups

Group	Age (years)	Weight (kg)	Height (cm)	ASA grade (I/II)	Operation time (min)	Male (n)	Female (n)
D	48±8	60±8	168±8	12/18	180±11	13	17
R	47±7	58±9	166±6	11/19	172±12	14	16

Table 2. Comparison of indicators of catheter in two groups

Group	Catheter time (second)	Incidence of moderate to severe pain (%)	Incidence of high catheter resistance (%)	Incidence of vascular injury (%)	Incidence of nerve paresthesia (%)
D	160±9	20	17	3	13
R	155±5	20	20	3	17

Table 3. Comparison of VAS score at different time points in two groups

Group	n	T_1	T_2	T_3	T_4	T_5
D	30	3.8±0.6	3.6±0.8	3.7±0.5	3.8±0.8	4.3±0.6
R	30	4.5±0.8[a]	4.4±0.8[a]	4.3±0.5[a]	4.2±0.8[a]	4.3±0.8[a]

Note: Compared with D group, [a]P < 0.05.

Table 4. Comparison of postoperative adverse reactions in two groups

Group	Dizziness (n)	Skin itching (n)	Nausea and vomiting (n)	Respiratory depression (n)
D	1	1	1	1
R[a]	2	3	2	3

Note: Compared with D group, [a]P < 0.05.

Results

As shown in **Table 1**, the basic information of two groups of patients showed no significant difference (P > 0.05). The success rate of the catheter block was 100% in both groups without significant difference (P > 0.05, **Table 2**). Compared with the R group, VAS score decreased at different time points after surgery in the D group (P < 0.05, **Table 3**), and the incidence of dizziness, nausea, and vomiting after surgery decreased in D group (P < 0.05, **Table 4**). However, the time to the first tramadol use and the number of patients to use tramadol and the dose of tramadol use within 48 h after surgery showed no significant difference in two groups (P > 0.05, **Table 5**). The analgesic satisfaction score at 48 h after surgery in two groups was listed in **Table 6**. The percentage of satisfaction was 90% in group D and 70% in group R, showing significant difference (P < 0.05). There were 2 cases of exudate and 1 case of catheter obstruction at 48 h after surgery in group R, but no catheter or local anesthetic related adverse event was observed in group D.

Discussion

Shoulder arthroscopy has gradually developed from a diagnostic method to a therapeutic approach in bone and joint surgery. Compared with traditional arthroplasty, shoulder arthroplasty has the advantages of a smaller incision, improved safety, wider indications, and less contraindication. Although the trauma after shoulder arthroscopic rotator cuff repair is small, the incidence of postoperative severe pain is still high, affecting postoperative activity and rehabilitation of the patients. Effective postoperative analgesia can improve the recovery of patients and reduce the length of hospital stay. Recent studies have shown that postoperative continuous brachial plexus block analgesia has better analgesic effects, fewer complications, and a higher satisfaction rating by the patient [4, 5].

The rotator cuff repair under arthroscopy is commonly performed in the beach chair position, and patients usually could not tolerate simple block anesthesia and need general anesthesia. Therefore, patients in this study were treated under general anesthesia and before general anesthesia the catheter was retained in the interscalene brachial plexus under the guidance of ultrasound. For interscalene brachial plexus block analgesia, accurate positioning is the key to good analgesic effects [6, 7]. Clinical positioning methods include anatomical positioning, susceptibility positioning, nerve stimulation device positioning, and ultrasound positioning. Anatomical positioning and susceptibility positioning are blind positioning methods, the success rate is low and the blood vessels and nerves may be damaged during

Table 5. Comparison of tramadol use after surgery in two groups

Group	n	Time to the first use of tramadol (hour)	Number of patients to take tramadol within 48 h use/no use)	Tramadol dose (mg)
D	30	28±11	6/24	166±57
R	30	27±10	12/18	183±40

Table 6. Comparison of analgesic satisfaction score in two groups

Group	n	Very satisfied	Satisfied	Neutral	Not satisfied
D	30	16	11	3	0
R[a]	30	10	11	5	4

Note: Compared with D group, [a]P < 0.05

the puncture. The use of nerve stimulation instruments can significantly improve the success rate of puncture but still cannot guarantee accurate positioning. In this study, under the guidance of ultrasound, the structure of the nerve and adjacent blood vessels, as well as the direction of the needle and the position of the catheter can be clearly observed. In the process of puncture, the needle can effectively avoid the nerves and blood vessels, and the catheter can be placed on the surface of the nerves to ensure that local anesthetic drug exerts effects and provides good analgesic effect of continuous interscalene nerve block.

In this study, after catheterization was completed, 20 ml 1% lidocaine was injected through the catheter. On one hand, the short onset time of lidocaine is used to test the effect of block as soon as possible to determine whether the catheter position is correct. On the other hand, because our surgery may lead to nerve injury, the surgeon needs to immediately check the limb motor function of the patients and investigate for potential neurological complications due to surgery. Lidocaine has a short duration of efficacy and ensures that the patients are able to cooperate with the check immediately after surgery.

In this study ropivacaine was selected as a nerve block drug, which has a wide range of actions, good safety, less adverse reactions, and little impact on the cardiovascular system. 0.2% ropivacaine is commonly used in the clinic for continuous nerve block analgesia [8]. DEX is a highly selective α_2 receptor agonist. In recent years, many studies have confirmed the advantages of DEX as a local anesthesia adjuvant in regional blockers, such as speeding up the block, enhancing the effect of action, and extending the time of action [9-11].

In this study, VAS scores of group D were lower than those of group R at 4, 8, 12, 24 and 48 h after surgery, indicating that the addition of DEX for continuous interscalene brachial plexus block analgesia can further reduce the pain score of patients after arthroscopic rotator cuff repair surgery compared to the use of ropivacaine alone.

It is postulated that the action of DEX as α_2 receptor agonist in peripheral nerve block may be achieved by peripheral vasoconstriction and/or central nervous system analgesia. However, Fritsch et al. used DEX + ropivacaine for brachial plexus block and found no significant difference in plasma concentrations of ropivacaine between the experimental group and the control group. These results denied that DEX extended local anesthetic action time through contracting peripheral blood vessels and slowing local anesthetic absorption [11]. Brummett et al. reported that the role of DEX in local nerve block could not be antagonized by α_1 and α_2 receptor antagonists, which demonstrated that the effect of DEX on local nerve block was not achieved by agonizing α_1 and α_2 receptors, but was achieved by inhibiting the activation of the hyperpolarized cationic current [12]. Dorothee et al. found that clonidine could enhance the inhibitory effect of lidocaine on the action potential of nerve fibers, suggesting that DEX may enhance the effect of local anesthetic through a similar mechanism [13]. In addition, DEX has an anti-inflammatory effect. Animal experiments showed that DEX played an anti-inflammatory role by downregulating or inhibiting the expression of inflammatory factors, thereby reducing postoperative hyperalgesia [14-17]. The mechanism of DEX to strengthen the analgesic effect of ropivacaine needs to be further studied.

In summary, the use of DEX + ropivacaine in postoperative continuous interscalene brachial plexus block analgesia can produce good anal-

gesic and sedative effects and reduce the incidence of postoperative complications in the patients undergoing arthroscopic rotator cuff repair surgery.

Disclosure of conflict of interest

None.

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