ORIGINAL RESEARCH

Signa Vitae

Dexmedetomidine on Continuous Infraclavicular Block after Elbow Arthrolysis

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Abstract

Aim: To evaluate the efficacy of dexmedetomidine in the analgesia of continuous infraclavicular brachial plexus block after elbow arthrolysis. **Methods:** Sixty patients who received unilateral elbow arthrolysis and met inclusion criteria 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 240 mL + 2 ug/kg dexmedetomidine in D group and 0.2% ropivacaine 240 mL in R group. The VAS scores at rest, 4 h (T1), 8 h (T2), 12 h (T3), 24 h (T4), 36 h (T5) and 48 h (T6) after operation were recorded, and NRS scores during functional exercise at 24 h (T4), 36 h (T5) and 48 h (T6) after operation were recorded. The incidence of adverse reactions and satisfactory degree of analgesia in two groups were recorded. **Results:** The success rate of block during catheterization was 100% in both groups. Compared with group R, VAS score of group D at each time point after operation decreased (p < 0.05); NRS score during functional exercise at each time point after operation decreased (p < 0.05); the additional pressing times of analgesic pump within 48 h decreased (p < 0.05); the incidence of dizziness, nausea and vomiting after operation decreased (p < 0.05); and satisfaction degree of analgesia 48 h after operation was higher in group D (p < 0.05). **Conclusion:** Dexmedetomidine combined with ropivacaine can produce effective analgesic and sedative effects, and reduce the incidence of complications in the analgesia of continuous infraclavicular brachial plexus block after elbow arthrolysis.

Keywords

Dexmedetomidine, Brachial plexus block, Elbow joint, Analgesia, Pain

1. Introduction

The anatomical structure of elbow joint is complex, and joint stiffness is prone to occur after trauma [1]. Arthrolysis is currently the main method to treat elbow joint stiffness [2]. The outcomes of arthrolysis depend largely on functional exercise during the early postoperative period, but passive activities after operation can cause severe pain. Therefore, effective postoperative analgesia is of great significance to such patients. Recent study indicated that continuous infraclavicular brachial plexus block is safe and effective for the analgesia after elbow arthrolysis [3].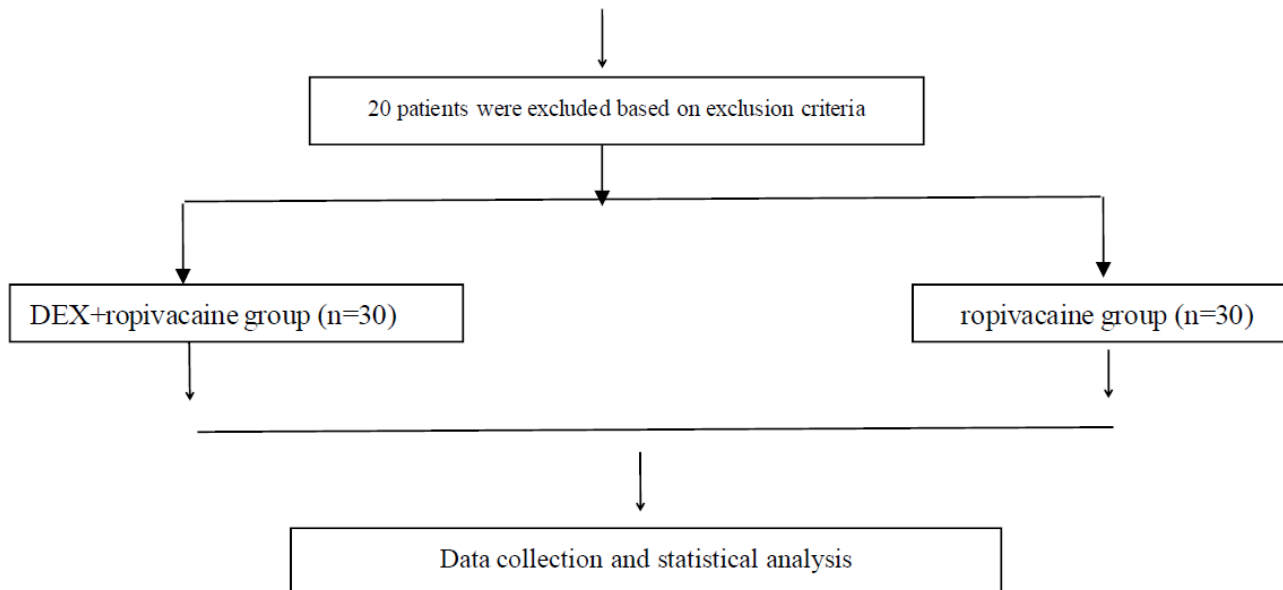 Dexmedetomidine (DEX) is a highly selective $\alpha2$ adrenergic receptor agonist, and has sedative, analgesic, anxiolytic, anti-inflammatory and hemodynamics-stablizing effects [4, 5]. Previously, we reported that DEX combined with ropivacaine had effective analgesic and sedative effects while reducing the incidence of complications in the patient-controlled interscalene brachial plexus block after arthroscopic rotator cuff repair [6]. However, current analgesia of continuous infraclavicular brachial plexus block after elbow arthrolysis is not satisfactory. Therefore, this study aimed to investigate the effect of DEX combined with ropivacaine on the analgesia of continuous infraclavicular brachial plexus block after elbow arthrolysis.

T A B L E 1. Comparison of general condition and operation time between two groups.

Group	Age (years)	Weight (kg)	Height (cm)	ASA grade (case, I/II)	Operation time (min)	Male (cases)	Female (cases)
D	48 ± 6	65 ± 8	169 ± 8	11/19	181 ± 11	16	14
R	47 ± 7	63 ± 9	168 ± 7	12/18	179 ± 12	17	13

T A B L E 2. Comparison of each indicator of catheterization between two groups.

Group	Catheterization time (sec)	Incidence of moderate to severe pain (%)	Incidence of high catheter resistance (%)	Incidence of vascular injury (%)	Incidence of nerve paresthesia (%)
D	165 ± 5	20	20	3	13
R	159 ± 9	20	20	3	17

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              20 patients were excluded based on exclusion criteria

   DEX+ropivacaine group (n=30)                    ropivacaine group (n=30)

                     Data collection and statistical analysis
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F I G U R E 1. Consort flow diagram showing the patients included in this study.

2. Materials and methods

2.1 Subjects

This study was approved by Ethics Committee of Cangzhou Central Hospital, and patients or family members signed written informed consent. Total 60 cases of patients were enrolled based on inclusion criteria: aged 40 – 64 years, ASA grade I to grade II, BMI 18 – 25 kg/m^2 and underwent unilateral elbow arthrolysis; and exclusion criteria: history of allergy to local anesthesia, serious cardiovascular or cerebrovascular diseases, diabetes with peripheral neuropathy, neurological damage, abnormal blood coagulation, and infection at the puncture site. Before operation, the patients were evaluated for visual analogue scale (VAS), and were divided into two groups (n = 30) by a random number table method: DEX + ropivacaine group (group D) and ropivacaine group (group R). The formulation of analgesic pump was 0.2% ropivacaine 240 ml + dexmedetomidine 2 ug/kg in group D as described in our previous study [6], and 0.2% ropivacaine 240 ml in group R.

2.2 Operations

Immediately before the operations, electrocardiogram (ECG), blood pressure (BP) and SpO$_2$ were routinely monitored, the peripheral venous access of the upper limb on the opposite of the affected limb was opened, and patients were anesthetized by intravenous injection of 0.03 mg/kg midazolam. Infraclavicular brachial plexus catheterization was performed as described previously [7]. The patients kept a supine position with the head of bed raised slightly, the arms were attached to the side of the body, and the head was biased to the opposite side. The deltopectoral groove was routinely disinfected, SonoSite S-Nerve Ultrasound System (USA) was placed under the deltopectoral groove along sagittal plane to locate brachial plexus. The axillary artery short-axis images were scanned and the probe was slightly tilted and rotated to search for hyperechoic nerve tracts usually located around the axillary artery at 3, 6 and 9 o'clock directions. The 18 G puncture needle with a length of 90 mm (Contiplex D, Braun, Germany) was inserted close to the posterior cord of deep brachial plexus, and 20 mL 0.5% lidocaine hydrochloride (Hualu Pharmaceutical

T A B L E 3. Comparison of VAS scores at different time points between two groups.

Group	n	T_1	T_2	T_3	T_4	T_5	T_6
D	30	3.8 ± 0.6	3.6 ± 0.8	3.7 ± 0.5	3.8 ± 0.8	3.6 ± 0.6	3.5 ± 0.6
R^a	30	4.5 ± 0.8	4.4 ± 0.8	4.3 ± 0.5	4.2 ± 0.8	4.3 ± 0.8	4.4 ± 0.8

[a] Compared with group D, $p < 0.05$ at each time point T_1 to T_6.

T A B L E 4. Comparison of NRS scores during functional exercise between two groups.

Group	n	T_4	T_5	T_6
D	30	3.0(3.0)	2.5(3.0)	2.0(3.5)
R^a	30	4.0(3.3)	3.4(3.3)	3.0(3.2)

[a] Compared with group D, $p < 0.05$ at each time point T_1 to T_6.

Co., Shandong, China) was injected. After the injection, the catheter was inserted through the puncture needle, and the catheter passed through the needle tip 3 - 5 cm. If there was no blood during catheter withdrawal, the needle was removed and the catheter was fixed, and the electronic analgesic pump was connected after operation. The brachial plexus motor and sensory block effects were measured within 30 min, and patients with failed brachial plexus block were excluded from this study. Puncture and catheterization were performed by the same anesthesiologist with experience.

The two groups received general anesthesia and were induced by intravenous injection of 2 ug/kg fentanyl, 2 mg/kg propofol and 0.1 mg/kg cisatracurium besylate. The sevoflurane was inhaled to maintain anesthesia, and monitored anesthesia care (MAC) value was maintained at around 0.8. During the operation, fentanyl and cisatracurium besylate were added intermittently according to the recovery of muscle relaxation and the operation process, and the changes of blood pressure and heart rate were maintained not to exceed 25% of the baseline value. 5 mg tropisetron was given intravenously 30 min before the end of the operation.

After the patients awakened from the operation, the laryngeal mask airway was removed after extubation indication was satisfied, and the patients were sent to the postanesthesia care unit (PACU). Then the patients were instructed to do finger-splitting and thumb-stretching exercises to determine possible ulnar and radial nerve injuries. When the patient felt pain at the surgical incision, 20 mL (extracted from the electronic analgesic pump) 0.2% ropivacaine (AstraZeneca, Sweden) was injected through catheter. After 15 min, the analgesia of patient-controlled brachial plexus block was performed, the background infusion rate was 5 mL/h, the PCA dose was 5 mL, and the lockout interval was 15 min. 48 h after continuous analgesia, the catheter was pulled out and the analgesic device was removed.

2.3 Measurements

The duration of catheterization (from needle contacting to skin until the end of injection via catheter) and the success of block were recorded. The degree of pain was assessed by NRS (0 is painless and 10 is unbearable severe pain). NRS score > 4 indicated moderate to severe pain. The catheter resistance was evaluated by the catheter resistance score method, and catheter resistance score > 1 indicated high catheter resistance. The occurrence of adverse reactions such as nerve paresthesia and vascular injury during catheterization was recorded. The VAS scores (0 – 10 points: 0 point for painless; 1 – 3 points for mild pain; 4 – 7 points for moderate pain; 8 – 10 points for severe pain) at rest, 4 h (T_1), 8 h (T_2), 12 h (T_3), 24 h (T_4) and 48 h (T_5) after operation were recorded; NRS scores during functional exercise at 24 h (T_4), 36 h (T_5) and 48 h (T_6) after operation were recorded. The time, user number and dose of tramadol used for the first time in patients taking tramadol were recorded. The incidence of adverse reactions such as dizziness, nausea and vomiting, itchy skin and respiratory depression were recorded. The satisfactory degree of analgesia (9 - 10: very satisfactory; 6 - 8: basically satisfactory; 4 - 5 general satisfactory; and 3 or less: not satisfied) 48 h after operation was recorded.

2.4 Statistical analysis

SPSS 13.0 statistical software was used to analyze the data expressed as mean $\pm$ standard deviation. The measurement data of normal distribution were compared by one-way analysis of variance or t test. The measurement data of skewed distribution were expressed by the median (interquartile range). The counting data were compared by χ^2 test. $p < 0.05$ was considered statistically significant.

3. Results

In this study we screened 80 patients who underwent unilateral elbow arthrolysis and excluded 20 patients based on exclusion criteria, and divided 60 patients into two groups in a randomized manner (Fig. 1). We found no significant difference in basic characteristics of the two groups ($p > 0.05$, Table 1).

The success rates of block of the two groups during catheterization were both 100%, and there was no significant difference in each indicator of catheterization of the two groups ($p > 0.05$, Table 2).

Compared with group R, the VAS score of group D at each time point after operation decreased ($p < 0.05$, Table 3). The NRS score during functional exercise at each

TABLE 5. Comparison of adverse reactions after operation between two groups.

Group	dizziness	itchy skin	nausea and vomiting	respiratory depression
D	1	1	1	1
R	2^a	2^a	2^a	1

^{a} Compared with group D, $p < 0.05$.

TABLE 6. Comparison of postoperative tramadol use between two groups.

Group	n	Time to take tramadol for the first time (h)	Composition of taking tramadol within 48 h (used/not used)	Dose of tramadol (mg)
D	30	28 ± 11	6/24	166 ± 57
R	30	27 ± 10^a	$12/18^a$	183 ± 40^a

^{a} Compared with group D, $p > 0.05$.

time point after operation decreased ($p < 0.05$, Table 4). The incidence of dizziness, nausea and vomiting after operation decreased ($p < 0.05$), and there was no significant difference in the incidence of respiratory depression ($p > 0.05$, Table 5).

The average pressing times of analgesic pump in group D within 48 h were significantly lower than that in group R (1.25 times vs. 4 times, $t = 2.914$, $p = 0.004$). There was no significant difference in the time, user number and dose of tramadol used for the first time in the two groups of patients after operation ($p > 0.05$, Table 6).

The satisfaction degree of analgesia 48 h after operation was 90% in group D and 70% in group R, and the difference was statistically significant ($p < 0.05$, Table 7).

There were 2 cases of leakage and 1 case of catheter blockage in group R within 48 h after operation, and no adverse reactions related to catheter and local anesthetics were observed in group D.

TABLE 7. Comparisons of postoperative satisfaction between two groups.

Group	n	Very satisfied	Satisfied	General	Not satisfied
D	30	15	12	2	1
R	30	11^a	10^a	6^a	3^a

^{a} Compared with group D, $p < 0.05$.

4. Discussion

Elbow arthrolysis is traumatic and has a high incidence of severe pain after operation. The severe pain during flexion and extension exercises leads to low activity after operation, which affects rehabilitation. Effective postoperative analgesia can alleviate pain and accelerate the recovery of patients. Studies have shown that continuous infraclavicular brachial plexus block had better postoperative analgesic effect, and caused fewer complications [3, 6]. Moreover, local anesthetic can dilate blood vessels by blocking sympathetic nerve, improve microcirculation of surgical site, and enhance anti-inflammatory effect of local tissue, thereby improving the prognosis of patients.

All the patients in this study underwent general anesthesia and the catheters were placed around the infraclavicular brachial plexus under ultrasound guidance before general anesthesia. For the analgesia of infraclavicular brachial plexus block, accurate positioning is the key to achieve good analgesic effect [8]. In this study, ropivacaine is selected as a nerve block drug because it has good safety, and causes less adverse reactions [9]. In clinic, 0.2% ropivacaine is often used as the analgesia of continuous nerve block [10]. DEX is a highly selective $\alpha 2$ receptor agonist used as an adjuvant of local anesthesia in regional block to accelerate the onset time of block, enhance the action effect and prolong the action time [11, 12]. Compared to another $\alpha 2$ receptor agonist adrenaline, DEX was more potent and caused less side effects in local anesthesia [13]. In this study, we used DEX and selected DEX dose based on our previous study [6]. The decreased incidence of dizziness, nausea and vomiting in group D after operation confirmed the role of DEX as an adjuvant of local anesthesia. At the same time, there was no significant difference in the incidence of respiratory depression between the two groups, indicating that the addition of DEX in electronic analgesic pump did not increase the incidence of respiratory depression.

The affected limb needs immobilization within 24 h after elbow arthrolysis, and functional exercise is performed after 24 h. In this study, the VAS scores at rest at 4, 8, 12, 24, 36 and 48 h after operation and the NRS scores during functional exercise at 24, 36 and 48 h in group D were lower than those in group R, indicating that DEX combined with ropivacaine for the analgesia of continuous infraclavicular brachial plexus block can reduce the pain scores of the patients after elbow arthrolysis compared with ropivacaine alone. On the other hand, within 48 h after operation in which analgesic pump was used, the average additional times of group D was significantly lower than that of group R. These results suggest that continuous analgesic effect was better in group D than in group R.

The sedative site of DEX is the locus coeruleus near the fourth ventricle, but the mechanism of DEX in peripheral zone block remains unclear. For brachial plexus block with

DEX combined with ropivacaine, there was no significant difference in plasma concentration of ropivacaine between the experimental group and the control group at 30, 60 and 180 min (p > 0.05), suggesting that it is unlikely that DEX prolonged the action of local anesthetics by contracting peripheral blood vessels and slowing the absorption of local anesthetics [12]. Brummett et al. reported in a randomized trial that the effect of DEX on nerve block could not be antagonized by $\alpha 1$ and $\alpha 2$ receptor antagonists, indicating that the effect of DEX was not achieved by activating $\alpha 1$ and $\alpha 2$ receptors, but by inhibiting the activation of hyperpolarized cationic current [14]. Dorothee et al. found that clonidine enhanced inhibitory effect of lidocaine on the action potential of nerve C fibers, suggesting that DEX may enhance the effect of local anesthetics through a similar mechanism [15]. In addition, DEX plays an anti-inflammatory role by inhibiting the expression of inflammatory factors, thereby alleviating postoperative hyperalgesia [16, 17]. In this study, the decrease of NRS scores during functional exercise after operation may be related to these mechanisms, but the mechanism of DEX to enhance analgesic effect of ropivacaine remains to be further investigated.

This study has several limitations. First, we only recorded VAS scores at rest and NRS scores during functional exercise at different time points within 48 h after operation and not after 48 h. Second, the groups with different doses of DEX were not set for comparison. Third, we did not evaluate the improvement of motion range of elbow joint of the patients by DEX.

In summary, DEX combined with ropivacaine can produce effective analgesic and sedative effects in continuous infraclavicular brachial plexus block after elbow arthrolysis.

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CONFLICT OF INTEREST

The authors report no conflicts of interest in this work.

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