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Comparing Two Concentrations of Ropivacaine in the Ultrasound Guided Axillary Nerve Combined with Musculocutaneous Nerve Block to Prevent Upper Extremities Tourniquet Syndrome during Surgery

Xin Huang[1], Yang Liu[2], Yue Kan[3], Bhushan Sandeep[4]

[1]Department of Anesthesiology, Sichuan Modern Hospital Chengdu, [2]Department of Orthopedic Surgery, Honghui Hospital, Xi'an Jiaotong University, [3]Department of Anesthesiology, Chengdu Southwest Hospital of Integrated Traditional Chinese and Western Medicine, [4]Department of Cardiothoracic surgery, Chengdu second People's Hospital, China

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Abstract

Background: To investigate two concentrations of Ropivacaine in tourniquet reaction under axillary nerve block combined with musculocutaneous nerve block in patients undergoing forearm surgery.

Methods: 510 cases of forearm trauma were divided into two groups, 285 cases in control group and 225 cases in experimental group. The control group was given 0.25% Ropivacaine 30ml under ultrasound guided axillary nerve combined with musculocutaneous nerve block, and the experimental group was given 0.5% Ropivacaine using same method. The onset of anesthesia, anesthetic effect, and duration of stay at the PACU, maintenance of effective analgesia, the adverse reaction rate, hemodynamic and tolerance of the tourniquet of the two groups were compared.

Results: Mean arterial pressure, heart rate and blood oxygen saturation of the experimental group were better with significant ($P < 0.00$) than control group; the amount of narcotic drugs, onset time of anesthesia and the VAS score was lower in the experimental group with statistically significant ($P < 0.00$). The rate of excellent and good effect of anesthesia in the experimental group was 100% higher than that the control group, the duration of stay in the PACU was shorter in the experimental group ($p<0.00$); the duration of analgesia was shorter, and the adverse incidence rate in the experimental group was lower than the control group ($p<0.00$).

Conclusion: The application of 0.5% Ropivacaine compare to 0.25% Ropivacaine can improve the hemodynamic stability and reduce the tourniquet pain significantly and improve anesthetic effect, reduce the incidence of adverse reactions, shorten the onset time of anesthesia.

Key words: Ultrasound guided axillary nerve block, upper limb surgery, tourniquet syndrome, Ropivacaine , anesthesia efficacy

Introduction

During forearm surgeries to prevent over bleeding is a challenging task for anesthesiologist. During surgery surgeons usually put the tourniquet and in the long-run, most of patients develop the tourniquet syndrome no matter under general anesthesia or the regional anesthesia [1] ,so how to prevent tourniquet syndrome is a critical challenge to maintain a stable hemodynamic for an anesthesiologist[2].The tourniquet syndrome happens after applying the tourniquet for a certain period of time and the patients appears restlessness, cold, sweat ,unbearable pain, excessive sense of pressure ,and elevated blood pressure[3,4].

Address for correspondence and reprint requests to:
Bhushan Sandeep, Department of Cardiothoracic surgery, Chengdu second People's Hospital
Email: dr.sandeep07@yahoo.com

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Our aim of this study is to compare two concentrations of Ropivacaine 0.25% and 0.5% with ultrasound-guided axillary nerve block combined with musculocutaneous nerve block in patients with hand surgery of tourniquet reaction. Axillary nerve block is the injection of local anesthetics from the axillary trunk; a form of anesthesia in which nerve block is formed in the area of the hand and it has been widely used in forearm surgery [5.6]. The anesthetic effect was better under ultrasound guided, the success rate of anesthesia can be significantly improved and the anesthetic complications can be dramatically reduced. But axillary nerve plexus blocking cannot lead to completely blocked because it's difficult to locate the musculocutanous nerve which is arises from the lateral fascicles of the axillary circuit and absence of musculocutanous nerve block can lead to severe tourniquet [7]. In addition, as the tourniquet placed for long time the patient's hemodynamic will be unstable, even after sedatives administration cannot relieve it. Yet, relevant studies have shown that there are significant differences in the anesthetic effect of different concentrations of local anesthetics [8,9]. In this study, ultrasound-guided axillary nerve combined with musculocutaneous nerve block was compared and analyzed.

Method

We retrospectively studied 510 patients older than 18 years from March 2019 to May 2020 according with ASA I-IV guideline undergoing surgery of forearm, (distal riduals ,ulnar ,wrist and elbow , fingers replantation) under ultrasound guided requiring upper arm tourniquet. The control group was given 0.25% Ropivacaine 30ml under ultrasound guided axillary nerve combined with musculocutaneous nerve block, and the experimental group was given 0.5% Ropivacaine using same method. Patients and their families were voluntarily signed Informed consent; this study has been approved by the medical ethics committee of Sichuan Modern Hospital Chengdu, Honghui Hospital, Xi'an Jiaotong University, Chengdu Southwest Hospital of Integrated Traditional Chinese and Western Medicine and Chengdu second People's Hospital. Exclusion criteria included refusal to participate, communication problems, pre-existing neuropathy, coagulopathy or allergy to local anesthetics. Tourniquet pain was assessed according to visual analogue scale (VAS) every 15 minutes. After entering the operation room, all patients were given intravenous access, oxygen inhalation via face mask, supine position, with the head titled to the unaffected side and the abduction of the affected limb perpendicular to the limb. Positioning and puncture were performed in the control group by color Doppler diagnostic equipment and the drobe frequency was 10-12Hz, single-use nerve block package .After located the AA (Axillary Artery) we can clearly see the ulnar ,radial and median nerves around the AA like scrobiculate, then we needed to press and rotate the probe to find the musculocutaneous nerve ,the musculocutaneous nerve usually arises from the lateral fascicles of the axillary circuit ,and is therefore difficult to be characterized as such when blind puncture. As a result, a failure of the axillary nerve block often results in a tourniquet reaction. After no blood was drawn back, the local anesthetic was slowly injected into the nerve trunk. At this time in the nerve trunk the surrounding liquid medicine spreads, and the liquid dark area on the cross section shows an onion ring-like change. We selected 150 mg Ropivacaine hydrochloride which was diluted with 0.9% sodium chloride injection to a concentration of 0.5% and 0.25% Ropivacaine. During the injection, the patients were repeatedly pumped back to ensure that there was no air and blood. The reaction of the patients was observed carefully. The control group was treated with 0.25% Ropivacaine 30ml under ultrasound guidance to block the axillary route combined with musculocutaneous nerve .The experimental group was given 0.5% Ropivacaine 30ml with the same anesthesia method .The anesthesia effect ,the duration of the patient tolerance to tourniquet and hemodynamics of the two groups were compared The onset of anesthesia, analgesia maintenance and

Table 1: Comparative study and general characteristics of two groups

Patient Characteristics			
Total no of patients	Control group	Experimental group	P-Value
510	285	225	0.88
Age(Years)	44.45 ± 18.61	43.31 ± 18.26	
Gender			
Male	185	135	0.5
Female	90	100	0.95
Weight(Kg)	72.17 ±11.49	71.63 ±3.67	
ASA			
1	150	115	0.64
11	115	95	0.74
111	15	11	0.43
1V	5	4	0.88
Axillary Blockade Radial Nerve			
Ropivacaine 0.25% (Minutes)	3.79±0.96	0	<0.001
Ropivacaine 0.5% (Minutes)	0	3.27±1.06	
Ulnar Nerve			
Ropivacaine 0.25% (Minutes)	3.79±1.07	0	<0.001
Ropivacaine 0.5% (Minutes)	0	3.12±1.09	
Median Nerve			
Ropivacaine 0.25% (Minutes)	3.92±1.16	0	<0.001
Ropivacaine 0.5% (Minutes)	0	3.29 ±1.09	
Musculocutaneous Nerve			
Ropivacaine 0.25% (Minutes)	4.72±1.15	0	<0.001
Ropivacaine 0.5% (Minutes)	0	4.29 ±1.08	

recovery were recorded The adverse reactions of the two groups were statistically analyzed, including abnormal feeling of hand, wrong stab and irritability. Evaluation criteria of curative effect [4]: A: excellent, the patient did not have pain, smooth, completed the operation; B: good, the patient has slight pain and needs sedative treatment; C: poor, the patient does not tolerant tourniquet pain and needs additional drug treatment or switch to general anesthesia.

Statistical method: SPSS 25.0: statistical software was used to analyze the data, Continuous variables were expressed as means ± SD or as absolute numbers (with percentage). Comparisons between groups were performed using the Student's t-test for the counting data; P < 0.05 was statistically significant.

Results:

A total of 510 patients underwent surgical treatment were randomly divided into two groups, with 275 patients in control group, including 185 males and 90 females, aged from 25 to 61 years, with an average age of (44.45 ± 18.61) years; 225 in experimental group, 135 males and 100 females, aged from 18years to 67years, the average age was (43.31 ± 18.26) years old. There was no significant difference in general data between the two groups (P > 0.05). (Table-1)

The anesthesia and analgesia efficacy, the experimental group 100%, higher than the control group 87.7 % (p<0.05) (Table-2)

The effect and recovery time of the experimental group was shorter than that of

Table 2: Comparing the anesthesia efficacy

Group	number	excellent	good	poor	percentage
Control	285	165	85	35	(87.7%)
Experimental	225	200	20	0	(100.00%)
p	0.88	0.17	0.04	0.2	-

Table 3: Duration of stay in the recovery room and maintenance of effective analgesia under anesthesia (Minutes)

Group	number	Onset of anesthesia	Maintenance of analgesia	Duration of stay at PACU
Control	285	7.99±1.19	362.73±14.84	32.74±7.55
p	0.88	<0.001	<0.001	<0.001

the control group (p<0.05), the average duration of analgesia time (5-6h) longer than the control group (2.5-3.5h) (p<0.05). (Table-3)

The adverse reaction rate in the experimental group was（15%）higher than control group (2%). (Table-4)

The investigation of this study shows that the rate of excellent and good effect of anesthesia in the experimental group was 100% higher than that the control group, the duration of stay in the PACU was shorter in the experimental group than the control group (p<0.00); The duration of analgesia was longer than control group (p<0.00）, and the adverse incidence rate in the experimental group was lower than the control group (p<0.00). The nerve damage in both of group was temporary and it was recovered before the discharge of patient from hospital.

Discussion

In recent years, ultrasound guided axillary nerve block combined musculocutaneous nerve block has greatly satisfied the needs of hand surgery to reduce the tourniquet syndrome of patients [10], and also this method has reduced the risk compared with intermuscular and supraclavicular nerve block pneumothorax, hemopnumothorax, total spinal anesthesia, nerve damage, phrenic nerve block, Honour syndrome, etc.) [11]. In our study use of Ropivacaine 0.5% reduces the amount of anesthesia dosage and improve onset time of anesthesia enhanced the analgesia quality.

The axillary nerve block mainly blocks the terminal branch of the median, radial, ulnar and musculocutaneous nerve. In recent years, it is widely used in operation on the forearm and below surgeries [12]. Musculocutaneous nerve arises from the lateral axillary, single nerve block lead to incompletely block, thus affecting the anesthetic effect. When the axillary nerve block combined with musculocutaneous nerve block is performed by color ultrasound localization, the brachial plexus nerve, musculocutaneous nerve and its surrounding tissues in the axillary path can be accurately observed and precisely located [13]. In addition, anesthetic drugs were injected under the guidance of ultrasound to improve the anesthetic effect, reduce puncture injury, and thus reduce the influence of anesthesia and surgical operation on hemodynamics and stress response of patients [14].

Ropivacaine is a kind of local anesthetic drug, belonging to a single structure long-acting amides S-type drug, with short onset time, long duration of action and low incidence of adverse reactions [15]. It can inhibit the nerve cell sodium ion channel, nerve excitation and conduction interruption. Relevant studies have shown that Ropivacaine has the characteristics of separating sensory and motor nerve block between Bupivacaine and lidocaine, and is the preferred drug for regional nerve block [16]. At present, the

Table 4: Comparing of adverse rates (%) between two groups

TGroup	number	hypertension	agitated	Sense of Tingling	Nerves damage
Control	285	12(4.2%)	13(4.6%)	11(3.9%)	9(3.1%)
Experimental	225	2(0.8%)	1(0.004%)	1(0.004%)	1(0.004%)
p	0.88	0.86	0.85	0.85	0.86

clinical application of Ropivacaine concentration and volume has become the focus of research. Usually within the effective concentration and volume, the same volume increases with the concentration of Ropivacaine, the onset time of nerve block is significantly shortened, and the analgesic duration is effectively prolonged [17]. If the anesthetic concentration is too low, the nerve block will not be complete, which can easily lead to hypoxic pain, especially in patients who need to tie a tourniquet and cause a severe tourniquet reaction [18]. Moreover, low concentration of Ropivacaine has poor diffusion ability, which will directly affect the blocking effect. Therefore, 0.5% Ropivacaine is widely used clinically for anesthesia. The relevant studies showed that the block duration of 0.75% Ropivacaine was too long due to the comparison of block plane [19]. However, Ropivacaine 0.33% has a wider pain block plane, a shorter duration, and an increased volume will increase the incidence of adverse reactions [20].

The findings of our study shows the excellent and good rate of anesthesia in the experimental group was 100%, higher than that in the comparison group ($p<0.00$). The effect of anesthesia was observed in the experimental group and the stay in the recovery room was shorter than that in the control group ($p<0.00$). The duration of analgesia was longer than that of the control group ($p<0.00$). The incidence of adverse reactions was lower than that of the control group ($p<0.00$), which was consistent with the results of relevant studies. Our results shows that the application of 0.5% Ropivacaine in the ultrasound guided axillary nerve combined with musculocutaneous nerve block can improve the anesthetic effect, reduce the incidence of adverse reactions, shorten the onset time of anesthesia, and prolong the maintenance time of analgesia

Conclusion

By administering 0.5% Ropivacaine to ultrasound guided axillary nerve block combined with musculocutaneous nerve block, the anesthetic effect can be improved, the tourniquet reaction and the incidence of adverse reactions can be reduced, the onset time of anesthesia can be shortened, and the analgesic maintenance time can be prolonged to reduce the incidence of adverse reactions.

Declarations:

Ethics approval and consent to participate: The protocol was approved by the Sichuan Modern Hospital Chengdu, Honghui Hospital, Xi'an Jiaotong University, Chengdu Southwest Hospital Of Integrated Traditional Chinese and Western Medicine, and Chengdu Second People's Hospital, Clinical Research Ethics Committee, and parents of all subjects provided informed consent. The ethics committee did not provide any number because four hospital were involved in this study.

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Author Contributions:

XH[1]: Concept/Design, Data analysis, drafting article, Critical revision of article, Approval of article.

YL[1]: Concept/Design, Interpretation, Critical revision of article, Approval of article.

KY[1]: Concept/Design, Interpretation, Critical revision of article, Approval of article.

BS[*]: Corresponding author, Concept/Design, Data analysis/interpretation, drafting article, Critical revision of article, Approval of article, Statistics, Funding, Data collection

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