Journal of Anesthesia & Clinical Research

Mogahed and Abd El Ghafar, J Anesth Clin Res
2017, 8:7
DOI: 10.4172/2155-6148.1000744

Research Article OMICS International

Ultrasound Guided Supraclavicular Brachial Plexus Block for Arterio-venous Shunt Surgery in Chronic Renal Failure, Comparative Study between Two Volumes of Bupivacaine

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Received date: Jun 16, 2017; **Accepted date:** July 25, 2017; **Published date:** July 28, 2017

Abstract

Background: There are different anesthetic techniques for AVF (Arterio-venous fistula) creation as general anesthesia, regional anesthesia and local anesthetic infiltration. Sympathetic nerve block is produced by regional anesthesia which increases intraoperative venous diameter and vessel flow, both intra-operatively and for several hours post-operatively. Regional anesthesia can maintain adequate blood flow through the fistula post-operatively which can prevent thrombosis and fistula failure and is important in fistula maturation.

Aim: The aim of this study was to evaluate the effect of two different volumes of bupivacaine in chronic renal failure patients with ultrasound-guided supraclavicular brachial plexus block in arterio-venous shunt creation surgery.

Methods: Patients were randomly classified using sealed envelope into two equal groups each of 25 patients; Group I: Patients received plain bupivacaine 0.5% (30 ml), Group II: Patients received plain bupivacaine 0. 5% (20 ml) In all groups, we measured the onset of sensory block, the onset of motor block, success rate , duration of motor and sensory block and complications.

Results: Insignificant difference between both groups according to onset of sensory block, insignificant difference between both groups according to onset of motor block, Significant prolongation in duration of sensory block in group I as compared to group II, significant prolongation in duration of motor block in group I as compared to group II. There was significant increase in the rate of complications in group I as compared to group II and there was no significant difference between the two groups as regard the success rate.

Conclusion: During ultrasound guided supraclavicular block in end stage renal disease (ESRD), administration of 20 ml bupivacaine 0.5% is equal to 30 ml bupivacaine 0.5% as regard the onset of sensory block, motor block and the success rate but with shorter duration as regard the sensory block and motor block and significant decrease in complications.

Keywords: Supraclavicular; A-V shunt ; Bupivacaine

Introduction

It is a difficult process to treat chronic kidney disease patients. Perioperative morbidity and mortality in chronic kidney disease patients can be lowered by understanding how to care for them [1]

Renal replacement therapy (RRT) is necessary for survival in irreversible end stage renal failure patients. Hemodialysis which is the commonest form of RRT and surgical creation of an arteriovenous fistula (AVF) are recommended for those patients [2].

There are different anesthetic techniques for AVF creation as general anesthesia, regional anesthesia and local anesthetic infiltration [3].

Sympathetic nerve block is produced by regional anesthesia which increases intraoperative venous diameter and vessel flow, both intra-operatively and for several hours post-operatively. Regional anesthesia can maintain adequate blood flow through the fistula post-operatively which can prevent thrombosis and fistula failure and is important in fistula maturation. Also, arterial and venous spasm reduces flow and is more common with local infiltration than regional or general anesthesia [4].

General anesthesia increases intra-operative vasodilatation and hypotension, chronic kidney disease (CKD) patients are known to be at increased risk of peri- and post-operative anesthetic complications. Many of these complications can be avoided if regional anesthesia is employed [5].

Systemic local anesthetic toxicity is still frequent and dose dependent. Therefore, reducing the dose of local anesthetic in regional anesthesia can contribute to the safety of regional anesthesia [6].

Minimum local anesthetic volume required for ultrasound guided supraclavicular block was 23 ml. However, many different dosages are described; an overall volume of 20 to 25 ml of local anesthetic in combination with ultrasound guidance is commonly accepted. Nowadays, many studies aim to prove equal efficacy with a reduction of the necessary volume [7].

The aim of this study was to evaluate the effect of two different volumes of bupivacaine in chronic renal failure patients with ultrasound-guided supraclavicular brachial plexus block in arterio-venous shunt creation surgery as 1ry outcome was onset and duration of sensory and motor block while secondary outcomes were complications and success rate.

Patients and Methods

Study design

This double blind randomized prospective study had been carried out in Anesthesia and Surgical Intensive Care department, Tanta University Hospitals for six months. A written informed consent had been obtained from all patients. Every patient received an explanation to the purpose of the study and had a code number to ensure privacy to participants and confidentiality of data.

Research results were only used for scientific purposes. Procedures had been approved by both the institutional and the regional ethical committees. Any unexpected risks appeared during the course of research had been clarified to the participants and the ethical committee in time.

Sample size

The sample size was calculated using Epi-Info software statistical package created by World Health organization and center for Disease Control and Prevention, Atlanta, Georgia, USA version 2002. The sample size was calculated at N=30.

The criteria used for sample size calculation were as follows:

95% confidence limit, 80% power, The ratio between experimental and control groups is 1:1, Expected outcome in in treatment group is double times better than control groups (40-80% of optimal required).

Study population

Adult patients with chronic renal failure which defined as progressive kidney damage with glomerular filtration rate (GFR)<15 mL/min/1.73 m^2 for 3 months or more irrespective of cause which is the point of needing dialysis with physical status ASA III classification scheduled for elective arterio-venous shunt creation surgery were included in our study. While patients with neurological deficit with upper limb, bleeding disorders (coagulopathy), mental dysfunction, history of drug abuse and chronic analgesic use, history of allergy to local anesthetics were excluded in our study. Patients were randomly classified using sealed envelope into two equal groups each of 25 patients by random selection of envelopes performed in the operating theatre. The envelopes were prepared in advance and contained a computer-generated randomization schedule. The pharmacist (who prepared the medication), the anesthetist (who did the technique), investigator (who did data collection and recording) and patient were blinded about the group assignment. Group I: Patients of this group received plain bupivacaine 0.5% (30 ml), Group II: Patients of this group received plain bupivacaine 0. 5% (20 ml).

Study intervention

Medical & surgical history of the patient were evaluated, clinical examination of the patient was performed, laboratory investigations included complete blood picture, prothrombin time& activity, liver and renal functions and electrolytes.

Routine monitoring of heart rate &rhythm by ECG, arterial blood pressure using non-invasive blood pressure (NIBP) including systolic, diastolic & mean arterial blood pressure, peripheral oxygen saturation (SPO_2) using pulse oximeter had been performed.

Equipment used included: Sterile towels and gauze packs, 20 mL syringes with local anesthetic, 25 gauge needle and 2 ml lidocaine 2%, Sterile gloves, gel and marking pen, 20 gauge, 50 mm length needle for infiltration of local anesthetics (visioplex®-vygon-france), Ultrasound machine (sonoscape® SSI-6000) and a 12 MHz linear type probe. The supraclavicular brachial plexus block was performed in supine position.

An intravenous (I.V) line was established with an 18 gauge cannula. While the patient was in supine position the skin was disinfected and a linear probe, high frequency 12 MHz was placed firmly over the supraclavicular fossa , the probe was positioned in the transverse plane immediately superior to the clavicle at approximately its midpoint. The probe was tilted caudally to obtain a cross-sectional view of the subclavian artery. The brachial plexus was seen as a collection of hypoechoic oval structures lateral and superficial to the artery.

Using a 25 gauge needle, 1 to 2 mL of lidocaine was injected into the skin 1 cm lateral to the probe to decrease the discomfort during needle insertion. The needle was advanced along the long axis of the probe in the same plane as the ultrasound beam. The needle shaft and tip can be visualized in real time as the needle was advanced towards the target nerves.

The volume of bupivacaine according to each group was injected under direct vision of ultrasound beams.

In both groups, the followings were measured: Onset of sensory block: checked with a needle every 5 min up to 30 min after injection of local anesthetic in all 5 cutaneous nerve distributions Musculocutaneous nerve: lateral side of the forearm, Radial nerve: dorsum of the hand over the 2nd metacarpophalangeal joint, Ulnar nerve: little finger, Median nerve: medial thenar eminence, and Medial cutaneous nerve: medial side of the forearm) [8]. Onset of motor block : checked every 5 min. up to 30 min. For motor block evaluation, the following nerves were assessed: Radial nerve (elbow extension against resistance), median nerve (flexion of the distal interphalangeal joint of the second finger), ulnar nerve (abduction of the middle and ring fingers), and musculocutaneous nerve (elbow flexion against resistance) [8]. Success rate: success means complete sensory and motor block. Duration of motor and sensory block in hours: checked every 15 min till the end of surgery. And complications: such as Horner's syndrome, chest discomfort, voice changes and pneumothorax.

The patients who had failed blockades that means no sensory block and no motor block received general anesthesia.

Statistical presentation and analysis of the present study was conducted, using the mean ± standard deviation, student´s t test (for quantitative data comparison between studied groups) and chi-square test (for qualitative data comparison between studied groups) by using SPSS software version 16. Statistically significant difference at p.value <0.05 (Figure 1).

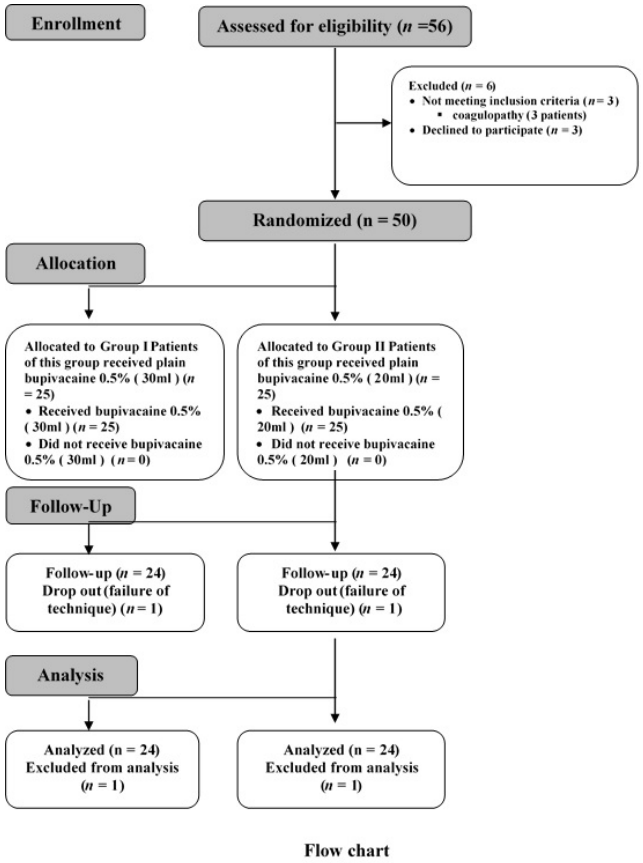

Figure 1: Statistical presentation and analysis of the present study.

Results

The study has been carried out in Tanta University Hospitals on 50 adult patients with chronic renal failure scheduled for elective arterio-venous shunt creation surgery.

Demographic data of patients in both groups shows insignificant difference as regard age, sex and weight (Table 1).

	Age(year)		Wt. (kg)		Sex	
	Group II	Group I	Group II	Group I	Group II	Group I
Mean	50.48	52.08	70.64	70.84	F/M	F/M
SD	5.4	6.3	5.89	6.06	8/17	11/14
t & X2	t=0.964		t=0.118		X2=0.764	
P-value	0.34		0.906		0.382	

Table 1: Demographic data of the studied patients (n=25) in each group.

Onset of sensory and motor block in both groups shows insignificant difference between both groups while duration of sensory and motor block shows significant prolongation in group I as compared to group II (Table 2).

Parameters	Groups	Mean	± SD	T	P-value
Sensory block onset time (mins)	Group I (n=25)	12.3	2.5	0.283	0.778
	Group II (n=25)	12.5	2.6		
Motor block onset time (mins)	Group I (n=25)	22.2	2.1	0.47	0.64
	Group II (n=25)	22.5	2.4		
Duration of sensory block (hours)	Group I (n=25)	33.6	1.19	2.887	0.006*
	Group II (n=25)	2.7	0.75		
Duration of motor block (hours)	Group I (n=25)	2.5	0.7	3.667	0.002*
	Group II (n=25)	1.8	0.73		
*Denotes statistically significant difference at p value < 0.05					

Table 2: The onset and duration of sensory and motor block.

Complications were significantly more in group I compared to group II,

We detected Horner's syndrome in 3 patients complained from red eye t (bloodshot conjunctiva, depending on the site of lesion), ptosis and miosis. These symptoms disappeared within 2 hours and half without any sequelae , voice change (hoarseness) in 2 patients that lasted for minutes & chest discomfort in 2 patients . In group II there was one patient with chest discomfort (Table 3).

	Group I (n=25)		Group II (n=25)	
	N	%	N	%
Horner's syndrome	3	12	0	0
Chest discomfort	2	8	1	4
Pneumothorax	0	0	0	0
Voice changes	2	8	0	0
Total complications	7	28	1	0
X^2	**5.357**			
P-value	**0.021***			

Table 3: Complications in both groups.

The success rate shows no significant difference between the two groups (Table 4).

Success rate	N	%
Group I (n=25)	24	96
Group II (n=25)	24	96

Table 4: Success rate in both groups.

Discussion

One-third of arterio-venous fistulae fail at an early stage. This failure rate is influenced by both the pre-operative arterial and venous diameters and post-operative flow through the AVF. Some anesthetic techniques can directly influence venous diameter as well as intra and post-operative blood flow [4]. General anesthesia, regional anesthesia such as brachial plexus block and local anesthetic (LA) infiltration are all acceptable anesthetic techniques for AVF creation [4]. Many complications can be avoided if regional or local anesthesia is employed. Only regional anesthesia produces an associated sympathetic nerve block which results in an increased intraoperative venous diameter and vessel flow, both intra-operatively and, for several hours, post-operatively. Maintenance of adequate blood flow through the fistula post-operatively can prevent thrombosis and fistula failure and is important in fistula maturation. Furthermore, arterial and venous spasm reduces flow and is more common with local infiltration than regional anesthesia [4].

The most important advantage of ultrasound for peripheral nerve block is the ability to confirm local anesthetic spread around the target nerve [8]. The operator can then manipulate the needle under direct vision to the appropriate depth and place the needle tip immediately adjacent to the target nerve [9]. In addition to imaging the needle and nerve, ultrasound clearly reveals the surrounding hazardous structures, including blood vessels, pleura, and viscera.

In this study the results showed that the success rate in group II with local anesthetic volume 20 ml was 96 %. In agreement with these results Song JG et al. estimated the minimum local anesthetic volume (MEV) for ultrasound-guided supraclavicular block in 95, 90, and 50% of patients were 17, 15, and 9 ml, respectively. However, the location of the needle near the lower trunk of brachial plexus and multiple injections withdrawing the needle should be performed to achieve these results, and very careful injection by a skillful operator is required [10]. Also, a study done by Bigeleisen et al. achieved 100% of success rate with 20 ml of local anesthetic (2.5 mg/ml bupivacaine, 10 mg/ml lidocaine, and 3 μg/ml epinephrine)by ultrasound-guided supraclavicular block that was performed on 55 patients [11]. Furthermore, Duggan et al. estimated minimal effective volume to be successful in 95% of patients (MEV95) and minimal effective volume to be successful in 50% of patients (MEV50) to be 42 ml and 23 ml (1.5% mepivacaine), respectively. According to the study results, it was concluded that they could not reduce the volume of local anesthetic in ultrasound-guided supraclavicular block [12]. Tran et al. showed that the minimum effective volume of lidocaine for ultrasound-guided supraclavicular block to be successful in 90% of patients (MEV90) for double-injection ultrasound-guided supraclavicular nerve block was estimated to be 32 mL lidocaine 1.5% with epinephrine 5 μg/mL. This volume (32 ml) for 90% success rate was lower compared with the conventional technique using 40 ml of local anesthetics [13].

In the current study the results showed that the difference between the two groups regarding to the onset of sensory and motor block was statistically insignificant. In agreement with these results, a study by Raizada et al. showed that there was no significant difference between the onset time of sensory and motor block between the three groups using different volumes and concentrations of mixture of bupivacaine 0.5% and lidocaine 1% [14]. Also, a study was done by Jeon et al. on 102 patients undergoing supraclavicular blocks with different volumes 35 ml, 30 ml, 25 ml, and 20 ml mepivacaine 1%, respectively. The average onset times of Group 35, Group 30, Group 25, and Group 20 were 14.3 ± 6.9 min, 13.6 ± 4.5 min, 16.7 ± 4.6 min, and 16.5 ± 3.7 min, respectively. There were no significant differences [8].

Results showed that the difference between the two groups regarding the duration of sensory and motor block was statistically significant with more prolongation in group I. A study by Raizada et al. showed that there was significant difference between the duration time of sensory and motor block between the three groups using different volumes and concentrations of mixture of bupivacaine 0.5% and lidocaine 1% with more prolongation in large volume group [14]. In a study done by Leonardo et al., they found that the blockades with low doses of local anesthetic 0.5% bupivacaine with 1:200,000 epinephrines were sufficient to perform the procedures with less than 2 h duration [15]. Furthermore, A study by Harper et al., supported the idea that low volumes of anesthetic Lidocaine 1.5% with epinephrine 1:200 000 can achieve the required sensory anesthesia for surgery, while minimizing the duration of the block. We speculate that increasing this volume would produce blocks of quicker onset and longer duration. This could have implications for day surgery, allowing more scope for regional anesthesia [16]. Moreover, Fredrickson et al., showed that low doses of local anesthetic decreased the blockade duration, defined as the time between the onset of blockade installation and the return of motor and sensory functions. Increasing the volume of ropivacaine 0.375% from 10 to 40 mL was estimated to increase median block duration. Increasing the concentration of 20 mL ropivacaine from 0.375% to 0.75% was estimated to increase block duration [17]. In agreement with our results, a study was done by Schoenmakers et al., the patients undergoing axillary blocks with two groups of different volumes showed prolonged duration with larger volume with significant differences between the two groups [18].

The results of this study showed that there were seven patients who complained of chest discomfort , Horner's syndrome, voice changes in group I with 30 ml local anesthetic whereas only one patient who complained of chest discomfort in group II with 20 ml local anesthetic. There was significant difference between the two groups regarding the total complications.

As acidosis decreases the central nervous system threshold to the toxic effects of local anesthetics, the total volume of anesthetic should be decreased by approximately 25 percent in the acidotic patients [19].

As regard to, Arcand et al. mentioned that no pneumothorax has been reported in any study of supraclavicular or infraclavicular block using ultrasound guidance [20]. Furthermore, Cornish et al. checked and evaluated complications, particularly dyspnea by hemidiaphragmatic paresis and observed the possibility of decreased incidence of hemidiaphragmatic paresis in supraclavicular block with a lower local anesthetic volume. Only one patient who received 21 ml of local anesthetic complained of chest discomfort and showed hemi-diaphragmatic paresis on the post-operative chest X-ray. No hemidiaphragmatic paresis was observed in the patients who received a local anesthetic volume<21 ml. Previous studies have reported a 35-60% incidence of hemi-diaphragmatic paresis after supraclavicular block using typical volumes of local anesthetics [21].

Conclusion

During ultrasound guided supraclavicular block in end stage renal disease (ESRD) patients, administration of 20 ml bupivacaine 0.5% is equal to 30 ml bupivacaine 0.5% as regard the onset of sensory block, motor block and the success rate but with shorter duration as regard

the sensory block and motor block and significant decrease in complications.

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