ORIGINAL ARTICLE

Effect of bupivacaine concentration on the efficacy of ultrasound-guided interscalene brachial plexus block

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ABSTRACT

Background: Interscalene brachial plexus block (ISBPB) is an effective technique for shoulder surgery and postoperative pain control. The aim of this study is to compare the analgesic efficacy of 0.1% *vs* 0.2% bupivacaine for continuous postoperative pain control following arthroscopic shoulder surgery. **Methods:** A total of 40 adult patients divided into two groups (each 20 patients) undergoing arthroscopic shoulder surgery were randomized to receive an ultrasound-guided ISBPB of either 0.1% or 0.2% bupivacaine 10 ml bolus plus 5 ml/h infusion through interscalene catheter. Standard general anesthesia was given. Both groups received rescue postoperative PCA morphine. Pain, sensory, and motor power were assessed before for all patients, 20 minute after the block, postoperatively in the recovery room, and at 2, 6, 12, and 24 hours thereafter. The patient and surgeon satisfaction and the analgesic consumption of morphine were recorded in the first 24 hours postoperatively. A nonparametric Mann-Whitney was used to compare between the two groups for numerical rating scale, morphine consumption in different time interval. **Results:** Group 1 (0.1% bupivacaine) patients had significantly received more intraoperative fentanyl and postoperative morphine with higher pain scores at 24 hours postoperatively *vs* group 2 (0.2% bupivacaine) patients. **Conclusions:** The use of ultrasound-guided ISBPB with 0.2% bupivacaine provided better intra- and post-operative pain relief *vs* 0.1% bupivacaine in arthroscopic shoulder surgery.

Key words: *Interscalene block, pain, shoulder arthroscopy*

INTRODUCTION

Arthroscopic shoulder surgery is often associated with severe postoperative pain which requires adequate postoperative pain control to achieve early mobilization and improve functional recovery. Therefore, development of improved postoperative modalities for arthroscopic shoulder surgery pain control is important. One commonly used modality is interscalene block. This technique has been shown to be effective in several recent investigations.[1,2] However, although complications of interscalene block are rare, such complications can be devastating.[3] In addition, it is not uncommon to achieve an incomplete nerve block,[4] which may incompletely control postoperative pain and which may be insufficient if regional anesthesia was planned.

The purpose of this study is to evaluate the efficacy of a 0.1% bupivacaine *vs* a 0.2% bupivacaine for postoperative pain relief in patients undergoing arthroscopic shoulder surgery.

Access this article online	
Quick Response Code:	Website: www.saudija.org
	DOI: 10.4103/1658-354X.82798

METHODS

After obtaining ethics committee approval and patient consent, 40 adult patients (ASA I or II) scheduled to undergo arthroscopic shoulder surgery were recruited to this double-blind, randomized controlled trial. Patients aged 23 years or older undergoing unilateral shoulder arthroscopy with rotator cuff and bankart lesion repairs were eligible for inclusion. Exclusion criteria included a history of shoulder injury, daily pain medication for problems not associated with the shoulder, medical

contraindications to regional anesthesia, and any motor or sensory defect. Participants were randomized into two groups (each 20 patients). For randomization, patients drew a sealed opaque envelope from a shuffled deck containing a card representing one of the treatment groups. Patients were not informed of their treatment group. In addition, the surgeon was not informed as to which concentration patients received.

Upon arrival of patients to the operation room, an 18 G venous cannula was inserted and patients connected to standard monitoring, O_2 face mask 5 l/min, 2 mg midazolam i.v.

One anesthesiologist experienced in regional anesthesia administered the blocks preoperatively using a standard protocol, also all cases done by one surgeon.

Patients were positioned in the supine position with the neck extended in the contralateral side to facilitate performance of US interscalene brachial plexus block (ISBPB). After sterile skin preparation with povidone-iodine and skin infiltration with lidocaine 1%, US ISBPB was performed. An 18-G, 2-inch insulated needle (B. Braun Medical Inc., Bethlehem, PA, USA) was inserted into the middle scalene muscle immediately, superior to and out of plane with the transducer. L38 × 10-5 MHz, linear array, 9 cm scan depth probe was used to visualize the brachial plexus [Figure 1] using SonoSite M-Turbo ultrasound machine (Bothell, WA, USA). At the middle portion of the scalene muscle, the needle was redirected anteriorly and advanced toward the interscalene space. Normal saline (1–2 ml) was injected in increments at the anterior border of the middle scalene muscle to expand the fascial plane between the brachial plexus and the middle scalene muscle. While intermittently aspirating, and under direct ultrasound visualization, 10 ml bupivacaine was injected into the interscalene space. The catheter 20 G was then inserted through the thin-walled needle to a depth of 10 cm into the skin. Before placement of a clear adhesive dressing, to locate the catheter position, 0.5 ml of air was injected after negative aspiration while imaging the interscalene space. The ultrasound image clearly demonstrated echogenic contrast entering within the interscalene space, confirming appropriate position of the catheter [Figure 2].

Patients in group 1 received 10 ml bupivacaine 0.1% as bolus, then infusion at a rate of 5 ml/h through the interscalene catheter. In group 2, patients received 10 ml bupivacaine 0.2% as bolus, then infusion at a rate of 5 ml/h through the interscalene catheter.

After the performance of ISBPB and initial assessment, patients were taken to the operating theatre where they were given a general anesthetic using a standardized protocol, consisting fentanyl 1 ug/kg, propofol 2 mg/kg, and tracheal intubation is facilitated with rocuronium 0.5 mg/kg and maintained with 1 MAC sevoflurane. Patients were given further intraoperative i.v. fentanyl

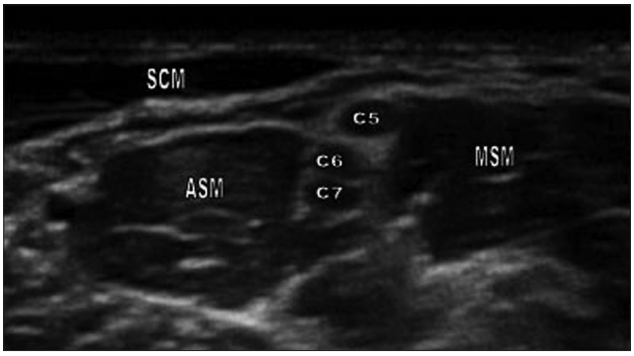

Figure 1: Brachial plexus components in the interscalene groove. SCM = sternocleidomastoid muscle, ASM = anterior scalene muscle, MSM = middle scalene muscle, C5, 6, 7 roots. Note the roots in the interscalene space. They appear hypoechoic (dark) with a hyperechoic (bright) rim

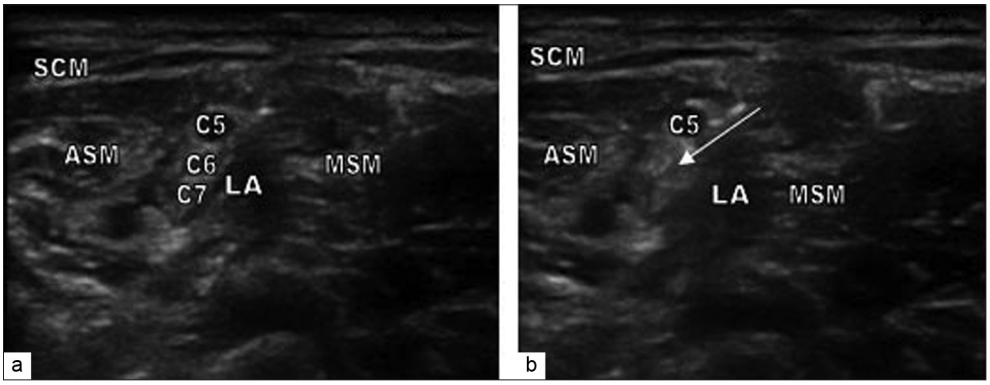

Figure 2: (a) An ultrasound image of the interscalene region after the injection of 10 ml of bupivacaine. The sternocleidomastoid muscle (SCM), anterior scalene muscle (ASM), middle scalene muscle (MSM), C5, 6, 7 roots, and the local anesthesia (LA) are displayed. The interscalene space has been expanded with 10 ml of local anesthetic. (b) The same view with an arrow indicating the echogenic contrast entering within the interscalene space, confirming appropriate position of the catheter

25 ug if heart rate or arterial pressure increased more than 25% above preinduction baseline values. No intra-articular local anesthetics were injected. At the end of surgery, reversal of muscle relaxant (atropine/neostigmine) was given in standard dosages and the trachea extubated. All patients were transferred to the recovery room for further assessment. PCA morphine 1 mg/ml with 6-minute lock-out time was used for patients as rescue analgesia. Data collection included numerical rating scale (NRS) for pain assessment, sensory and motor block assessed baseline, 20 minute after block, postoperatively in recovery room, and at postoperative 2, 6, 12, and 24 hours. Sensation of the upper extremity was assessed by pinprick using a 23-G needle testing from C5 to T1 dermatomes and scored as full sensation = 1 and loss of sensation to touch or pinprick = 0. Motor power assessment of the finger flexion (median), finger extension (radial), and finger abduction (ulnar) was scored as movement present = 1 and no movement present = 0. Patient and surgeon satisfaction and the analgesic consumption of morphine were assessed in the first 24 hours.

At the time of discharge, patients were given a prescription for Tylenol 3, 2 Tablets orally every 6 hours PRN.

Statistical analyses were performed to compare between the two groups, 0.1 and 0.2%, for nominal variables (gender, ASA, patient satisfaction, number of patients received intra operative analgesia and sensation and movement present) which used Fisher's exact test and Chi-square test. A Student *t*-test was also used to compare the two groups, 0.1 and 0.2%, for Measurable variables (age, weight, height, and surgery time). A nonparametric Mann-Whitney was used to compare between the two groups for NRS, morphine consumption in different time, where this data do not follow normal distribution. Statistical significance was set at *P*-value less than 0.05 for each test.

RESULTS

Nonsignificant difference was found in the patient characteristics between both groups [Table 1]. Nine patients in group 1 and 2 patients in group 2 received intraoperative fentanyl ($P = 0.013$). Pain score (NRS) recorded before the block, 20 minutes after the block, in the recovery room, 2, 6, 12, and 24 hours after surgery showed significant difference at 24 hours after surgery in group 1 ($P = 0.039$) [Table 2 and Figure 3].

The results for the number of patients who used morphine and total morphine-equivalent consumption in the recovery room, 2, 6, 12, and 24 hours after surgery, are illustrated

Table 1: Patient characteristics

	0.1% (*n* = 20)	0.2% (*n* = 20)	*P*-value
Gender			
Male (%)	16 (80)	15 (75)	0.50
Female (%)	4 (20)	5 (25)	
Age			
Mean ± SD	40.05 ± 16.96	39.75 ± 12.80	0.950
Weight			
Mean ± SD	73.56 ± 12.20	79.32 ± 15.79	0.204
Height			
Mean ± SD	165.0 ± 9.09	167.55 ± 7.88	0.349
ASA			
I (%)	12 (60)	16 (80)	0.168
II (%)	8 (40)	4 (20)	
Surgery time			
Mean ± SD	97.35 ± 23.14	93.10 ± 29.48	0.615
Patient satisfaction			
Partial satisfy (%)	3 (15)	5 (25)	0.347
Completely satisfy (%)	17 (85)	15 (75)	

Table 2: Comparison the pain score for both groups in different times

Pain score	0.1% (*n* = 20)	0.2% (*n* = 20)	*P*-value
Baseline			0.644
Median (Min. – Max.)	3 (0 – 10)	3.5 (0 – 9)	
Mean ± SD	3.58 ± 3.82	3.90 ± 3.55	
20 minutes after block			0.957
Median (Min. – Max.)	0 (0 – 1)	0 (0 – 1)	
Mean ± SD	0.11 ± 0.315	0.10 ± 0.308	
Rec. room			0.988
Median (Min. – Max.)	1 (0 – 7)	0 (0 – 10)	
Mean ± SD	1.74 ± 2.232	2.05 ± 3.017	
2 h			0.749
Median (Min. – Max.)	2 (0 – 4)	0.50 (0 – 8)	
Mean ± SD	1.47 ± 1.54	1.85 ± 2.39	
6 h			0.845
Median (Min. – Max.)	1 (0 – 7)	1.5 (0 – 6)	
Mean ± SD	1.79 ± 2.04	1.95 ± 2.235	
12 h			0.763
Median (Min. – Max.)	1 (0 – 9)	0.5 (0 – 8)	
Mean ± SD	1.68 ± 2.335	1.70 ± 2.452	
24 h			0.039
Median (Min. – Max.)	2 (0 – 7)	1 (0 – 4)	
Mean ± SD	2.05 ± 1.87	1.0 ± 1.214	

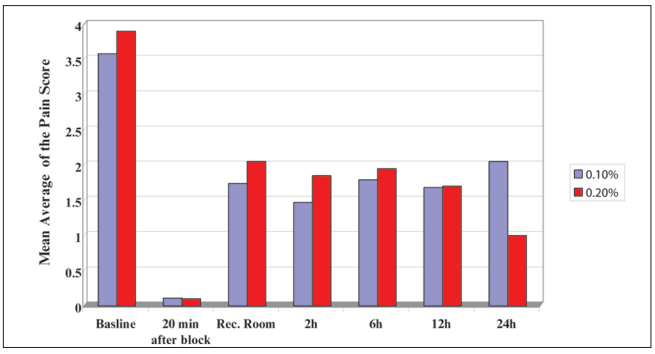

Figure 3: Comparison of the pain score for both groups in different times

in [Tables 3 and 4]. No statistically significant differences were identified in both groups. Sensory assessments were similar in both groups. Motor power assessment of the median *(Fingers Flexion)*, radial *(Fingers Extension)*, and ulnar *(Fingers Abduction)* nerves showed 1 patient in group1 scored 0 (no movement present) for median nerve at 20 minutes after block, 2 patients in group1 scored 0 for radial nerve at 20 minutes after the block and at recovery room after the surgery, and 3 patients scored 0 for ulnar nerve at 20 minutes after the block, at recovery room after the surgery and 12 hours after the surgery, but there was no significant difference between the 2 groups [Table 5].

DISCUSSION

To the best of our knowledge, this is the first prospective, randomized study to compare the effectiveness of postoperative pain control by using different concentration of bupivacaine 0.1 and 0.2%.

The selection of the local anesthetic and concentration for ISBPB must take into consideration the duration of blockade and side effects of drug and dose.

The results of this study suggested that there was statistical difference in number of patients who received intraoperative fentanyl and pain control at 24 hours post-ISBPB in group 0.1% bupivacaine, but no significant difference in morphine use, sensory, and motor effect between the two groups.

Table 3: Comparison of the number of patients who receive morphine in different times

	0.1% (*n* = 20)	0.2% (*n* = 20)	*P*-value
Rec. room (%)	3 (15)	1 (5)	0.302
2 h (%)	7 (35)	4 (20)	0.288
6 h (%)	9 (45)	9 (45)	0.999
12 h (%)	10 (50)	7 (35)	0.337
24 h (%)	13 (65)	8 (40)	0.113

Ultrasound-guided nerve block allows direct visualization of target nerves, adjacent anatomical structures, and needle position. As a result, the spread of local anesthetic around target nerves can be assessed and more precisely administered at the correct location. In this study, ultrasound allowed us to visualize the brachial plexus at the interscalene groove and administer a local anesthetic at the C5, C6, and C7 nerve roots.

Reported complications of interscalene block included phrenic nerve injuries with respiratory distress,[5,6] spinal anesthesia,[7] anesthetic toxicity leading to cardiac arrest,[8,9] seizures,[10] and nerve injury.[11,12] A retrospective review of interscalene regional anesthesia in a community setting reported a failure rate of 13%, with 33% of patients requiring intravenous pain medication immediately postoperatively,[5] leading to the conclusion that the benefits of the block need to be weighed carefully against the risks. In the present study, no complications were recorded.

In conclusion, bupivacaine 0.2% provided better pain control intraoperatively and at 24 hours after the block, with no significant difference with 0.1% in morphine consumption, patient satisfaction, sensory and motor

Table 4: Comparison of the morphine consumption in different times

	0.1% (*n* = 20)	0.2% (*n* = 20)	*P*-value
Rec. room			0.243
Median (Min. – Max.)	2 (0 – 4)	0 (0 – 4)	
Mean ± SD	1.8 ± 1.79	0.80 ± 1.79	
2 h			0.365
Median (Min. – Max.)	0 (0 – 3)	0 (0 – 2)	
Mean ± SD	1.0 ± 1.41	0.60 ± 0.89	
6 h			0.793
Median (Min. – Max.)	0 (0 – 5)	2 (0 – 4)	
Mean ± SD	1.60 ± 2.30	1.60 ± 1.67	
12 h			0.234
Median (Min. – Max.)	2 (0 – 3)	0 (0 – 3)	
Mean ± SD	1.80 ± 1.30	0.60 ± 1.34	
24 h			0.946
Median (Min. – Max.)	2 (0 – 6)	0 (0 – 2)	
Mean ± SD	2.60 ± 2.41	0.40 ± 0.89	

Table 5: Comparison between the two groups with respect to the percentage of movement present

	Median fingers flexion			Radial fingers extension			Ulnar fingers abduction		
	0.1% group (*n* = 20)	0.2% group (*n* = 20)	*P*-value	0.1% group (*n* = 20)	0.2% group (*n* = 20)	*P*-value	0.1% group (*n* = 20)	0.2% group (*n* = 20)	*P*-value
Baseline (%)	100	100		100	100		100	100	
20 minutes after block (%)	95	100	0.50	95	100	0.50	95	100	0.50
Rec. room (%)	100	100		95	100	0.50	95	100	0.50
2 h (%)	100	100		100	100		100	100	
6 h (%)	100	100		100	100		100	100	
12 h (%)	100	100		100	100		95	100	0.50
24 h	100	100		100	100		100	100	

effects. Further studies are needed on large number of patients to confirm our result.

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How to cite this article: Tariq A, Abdulaziz A. Effect of bupivacaine concentration on the efficacy of ultrasound-guided interscalene brachial plexus block. Saudi J Anaesth 2011;5:190-4.

Source of Support: Nil, **Conflict of Interest:** None declared.