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Original Article

The extent of blockade following axillary, supraclavicular, and interscalene approaches of brachial plexus block

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Aim: To investigate the onset, quality, and extent of the sensory and motor blocks in brachial plexus blocks performed through axillary, supraclavicular, or interscalene approaches.

Materials and methods: This study involved 75 patients scheduled for orthopedic surgery of the upper extremity. Brachial plexus block was performed in patients through axillary (group AX, n = 25), supraclavicular (group SC, n = 25), or interscalene (group IS, n = 25) approaches.

Results: Excluding intercostobrachial nerve, the adequate sensory and motor block rates in group AX on the nerves of brachial plexus were found to be 100% and 92%-100%, respectively. Sensory and motor block rates were both found to be 96%-100% in group SC and also 80%-100%, and 88% in group IS, respectively. In terms of sensory and motor block evaluation of all the nerves, there were statistically significant differences among the 3 groups at all measurement times (P < 0.05).

Conclusion: The onset, quality, and extent of the sensory and motor block in brachial plexus blocks changed depending on the axillary, supraclavicular, or interscalene approaches.

Key words: Brachial plexus block, axillary, supraclavicular, interscalene

Aksiller, supraklavikular ve interskalen yaklaşımlar ile uygulanan brakiyal pleksus bloğunun yayılımı

Amaç: Bu çalışmanın amacı, aksiller, supraklaviküler veya interskalen yaklaşım yoluyla gerçekleştirilen brakiyal pleksus bloklarında duyusal ve motor bloğun başlangıcı, kalitesi ve yayılımını araştırmaktır.

Yöntem ve gereç: Çalışma, ortopedik üst ekstremite cerrahisi planlanmış 75 hastayı içermektedir. Hastalarda aksiler (grup AX, n = 25), supraklaviküler (grup SC, n = 25) veya interskalen yaklaşım (grup İS, n = 25) yoluyla brakiyal pleksus bloğu gerçekleştirilmiştir.

Bulgular: Grup AX'de interkostobrakiyal sinir hariç olmak üzere brakiyal pleksusa ait sinirlere ilişkin yeterli duyusal blok oranı % 100, yeterli motor blok oranı ise % 92-100 olarak bulunmuştur. Grup SC'de duyusal ve motor blok oranlarının her ikisi de % 96-100, grup İS'de ise bu oranlar sırasıyla % 80-% 100 ve % 88 olarak bulunmuştur. Duyusal ve motor blok yönünden, değerlendirilen tüm sinirlerde, ölçüm yapılan tüm zaman dilimlerinde, üç grup arasında anlamlı fark vardır (P < 0,05).

Sonuç: Brakiyal pleksus bloğunda duyusal ve motor bloğun başlangıcı, kalitesi ve yayılımı uygulanan aksiller, supraklavikular veya interskalen yaklaşıma bağlı olarak değişmektedir.

Anahtar sözcükler: Brakiyal pleksus bloğu, aksiller, supraklaviküler, interskalen

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Introduction

Brachial plexus block is a multifunctional and reliable regional anesthesia that is performed through various blocks for upper extremity surgery. In planning brachial plexus block, the operation should be diagnostic or therapeutic, and several factors, such as the duration and site of the operation, postoperative analgesia, general condition of the patient, absence of accompanying diseases, and overnight hospitalization, should also be considered (1,2).

This study was aimed to investigate the onset, quality, and extend of sensory and motor blocks in brachial plexus blocks, and partially, cervical plexus through axillary, supraclavicular, and interscalene approaches by the use of local anesthetics containing a mixture of lidocaine and bupivacaine in equal amounts.

Materials and methods

This study was approved by the Institutional Ethics Committee, and informed consent was obtained from each patient. This study included patients of ASA physical status I-II, aged between 18 and 65 years, scheduled for elective orthopedic surgical procedures involving only soft tissue of the upper arm, lower arm, or hand. Brachial plexus block was performed in patients through axillary (group AX, n = 25), supraclavicular (group SC, n = 25), or interscalene (group IS, n = 25) approaches according to the site on which surgery will be conducted. Patients were excluded if they had a history of neurological, neuromuscular, or psychiatric disorders or hepatic, renal, respiratory, or cardiac disease. Patients with a history of drug or alcohol abuse, coagulation disorders, uncontrolled seizures, and pregnant or lactating women were excluded as well.

No premedication was given to the patients, whose routine laboratory examinations were made preoperatively, since full cooperation during block assessment was required. On arrival in the anesthetic room, an intravenous catheter was placed in the upper limb contralateral to the surgical site and saline solution was given at a rate of 2 mL/kg per hour. Monitoring included electrocardiography, non-invasive blood pressure and pulse oximetry. Supplemental oxygen (via nasal cannula at 4 L/min) was applied throughout the procedure.

All blocks were performed according to previously described techniques (3-5) by the first author and were supervised by the second author, who possesses experience with all the 3 approaches. The blocks in all groups were performed via a peripheral nerve stimulator (Stimuplex HNS® 11; B. Braun, Melsungen, Germany) and a short-beveled stimulating needle (Stimuplex® Kanüle A, 50 mm; B. Braun, Melsungen, Germany).

The perivascular axillary approach was performed in a supine patient with the upper arm abducted 90°, and flexed 90° cranially at the elbow with a supinated forearm. After identification of the axillary artery, the needle was inserted as high as possible in the axilla superior and tangential to the axillary artery (3). Supraclavicular approach was performed in a supine patient with a needle inserted above the subclavian artery directing the tip of the needle dorsolaterally (4). Interscalene approach was performed with the patient in the supine position. The needle was inserted at the level of the cricoid cartilage, in the interscalene groove and directed in a slightly caudal, medial, and dorsal direction (5).

For all approaches, the volume of the local anesthetics (approximately 30-35 mL) was calculated based on the height of each patient according to the following formula: volume (mL) = height (cm) / 5 (6), and the volume determined was prepared by mixing 2% lidocaine and 0.5% bupivacaine in equal proportions. In all patients undergoing the procedure, the plexus was identified with a short-beveled electric stimulation needle connected to a nerve stimulator using a low current (<1.0 mA).

For axillary approach, the median, radial, ulnar, and musculocutaneous nerves were selectively localized by elicited characteristic muscle group movements secondary to each nerve stimulation. After obtaining an appropriate peripheral motor response with a current near or below 0.5 mA with respect to the stimulation of each nerve, predetermined volumes of local anesthetics in accordance with the formula was selectively injected in each nerve through multiple injections in the AX group, with intermittent aspiration. Firm digital pressure was maintained during the injection and 3 min thereafter immediately distal to the injection site to prevent distal flow of the local anesthetic solution. The arm was then brought to rest at the patient's side.

For supraclavicular approach, the current was reduced until appropriate twitching of the hand, and also for interscalene approach the current was reduced until appropriate flexion of the shoulder, arm, or hand was achieved near or below 0.5 mA and then predetermined volumes of local anesthetic accordance with the formula was injected over 1 min, with repeat aspirations every 5 mL. Verbal contact with the patients was maintained throughout the injection, and before the injections were made, the patients were informed about the signs of local anesthetic toxicity, such as numbness of the lips and tongue, and lightheadedness.

Sensory and motor blocks of all upper extremity nerves were evaluated at the 3rd, 6th, 9th, 12th, 15th, 18th, and 30th min after injection and recorded on a chart. The patients were followed up for 24 h including both intraoperative and postoperative periods. During that period, side effects and complications were recorded. Sensory block was assessed in the area propria of the sensory nerves by pinprick using the blunt end of a 27-gauge dental needle and was graded according to the following rating scale (7): 0 = sharp, 1 = dull (analgesia), and 2 = no sensation (anesthesia). Motor block was tested using 6 different nerves. The motor block quality was evaluated based on the function of the muscle innervated by each nerve by observing the motion of the related muscle in each patient and the degree of the motion. The rating scale (7) for motor block was: 0 = normal contraction, 1 = reduced contraction (paresis), and 2 = no contraction (paralysis). Frequencies of sensory and motor block of different nerves of the upper extremity were determined for each of the 3 approaches. For clarity, either analgesia or anesthesia was evaluated as indicative of the adequate sensory block. Additionally, either paresis or paralysis was evaluated as indicative of the adequate motor block. Before the operation, a pinprick test was conducted in the operation site, and if pain was felt (inadequate sensory block), additional peripheral nerve block was provided by injection of 3-5 mL of 2% lidocaine. Requirements for additional local anesthetic infiltration were noted. After the operation, patients were monitored in the postanesthesia care unit (PACU) and were discharged from the hospital after recovery from sensory and motor block.

Statistical analysis

SPSS version 14 (SPSS, Chicago, IL, USA) was used to perform statistical analysis. Kolmogorov-Smirnov test was used first to assess the normality of the continuous data. One-way variance analysis was then used to analyze the continuous data. For multiple comparisons, post hoc testing was performed using the Tukey tests. Kruskal-Wallis test was used for categorical data, and Mann-Whitney U test was used for post hoc analysis. For the adjustment of multiple comparisons, Holm's sequential Bonferroni method was used. Continuous variables are presented as mean (SD); categorical data are presented as numbers or percentages. The hypotheses that were tested were 2-tailed. $P < 0.05$ was considered statistically significant.

Results

Demographic data, except for gender ($P < 0.01$) were not significantly different among the groups. No differences were observed in terms of the durations of operation (Table 1).

Since axillary, supraclavicular, and interscalene approaches were used in this study, the evaluation of the sensory and motor nerves starting from the onset of the block until the 30th minute revealed that the block rate of each nerve was slower or faster than or parallel to each other. In order to allow the onset of surgery and provide anesthesia throughout the operation, the quality of the sensory and motor block at the 30th minute is important for us to be able to determine whether an additional peripheral block is needed. The distribution of surgical procedures and the number of patients that require additional peripheral nerve block are presented in Table 2.

Evaluation of occipital minor and transverse colli nerves of cervical plexus at all measurement times showed that the nerves were not affected in the AX group (Table 3). In the SC group, the adequate sensory block rate remained between 12% and 20% (n = 3 and n = 5). However, in the IS group, the blocks attained were parallel for both nerves and at the 30th minute the adequate sensory block rate was determined to be 72% (n = 18) and 84% (n =

Table 1. Patient demographic characteristics and duration of operation (mean ± SD).

Groups	AX (n = 25)	SC (n = 25)	IS (n = 25)	P value
Gender (M/F)	9/16	11/14	3/22	< 0.01
ASA physical status (I/II)	14/11	10/15	6/19	NS
Age (years)	40.1 ± 14.1	42.5 ± 13.9	46.2 ± 12.1	NS
Weight (kg)	70.1 ± 12.1	70.4 ± 12.4	68.6 ± 11.4	NS
Height (cm)	165.0 ± 7.5	165.4 ± 6.4	161.2 ± 7.1	NS
Duration of operation (min)	51.6 ± 36.7	47.4 ± 26.9	37.3 ± 14.6	NS

AX: Axillary, SC: Supraclavicular, IS: Interscalene
ASA: American Society of Anesthesiologists
NS: Not Significant

Table 2. The distribution of the surgical procedures and the number of patients requiring additional peripheral nerve block [n (%)].

Groups Type of procedures	AX (n = 25)	SC (n = 25)	IS (n = 25)
Hand surgery	10 (40)		
Wrist surgery	6 (24)		
Lower arm surgery	5 (20)		
Elbow surgery	4 (16)	10 (40)	7 (28)
Upper arm surgery		15 (60)	18 (72)
Inadequate sensory block			
Musculocutaneous		1 (4)	
Radial		1 (4)	
Median			2 (8)
Ulnar			1 (4)

AX: Axillary, SC: Supraclavicular, IS: Interscalene

21), respectively. Besides, different adequate sensory blocks, which were statistically significant (P < 0.001) were provided on both nerves in the IS group (Table 3).

At the 30th minute, in the AX, SC, and IS groups, the adequate motor block rates of the dorsal scapular nerve, which is the motor branch of cervical plexus, were determined to be 40%, 96%, and 88%, respectively (Table 4). There was no statistically significant difference between SC and IS groups. However, in SC and IS groups, there was a statistically significant (P < 0.001) difference in comparison with the AX group (Table 4).

When the axillary nerve was assessed, statistically significant differences were observed among the groups at the 3rd minute (P = 0.020) in terms of sensory block (Table 3) and at the 3rd and 6th minutes (P = 0.030 and P = 0.037) in terms of motor block (Table 4). At the 30th minute, the rate of adequate sensory block for axillary nerve in groups AX, SC, and IS were 100%, 96%, and 100%, respectively, and the adequate motor block rates were found to be 100%, 96%, and 88%, respectively.

In terms of sensory block, there were statistically significant differences among the 3 groups at the 3rd,

Table 3. Development of sensory block with axillary (AX), supraclavicular (SC) or interscalene (IS) approach for brachial plexus block.

Nerves		3 min	6 min	9 min	12 min	15 min	18 min	30 min
	AX	25/0/0	25/0/0	25/0/0	25/0/0	25/0/0	25/0/0	25/0/0
Occipital minor	SC	22/3/0	22/3/0	22/3/0	22/3/0	22/3/0	22/3/0	22/3/0
	IS	10/14/1	10/14/1	10/14/1	8/15/2	8/14/3	8/14/3	7/13/5
$P < 0.05$		b,c	b,c	b,c	b,c	b,c	b,c	b
	AX	25/0/0	25/0/0	25/0/0	25/0/0	25/0/0	25/0/0	25/0/0
Transverse colli	SC	20/5/0	20/5/0	20/5/0	20/5/0	20/5/0	20/5/0	20/5/0
	IS	7/16/2	7/16/2	7/16/2	5/17/3	5/16/4	5/16/4	4/14/7
$P < 0.05$		b,c	b,c	b,c	b,c	b,c	b,c	b,c
	AX	3/22/0	2/23/0	1/18/6	1/18/6	1/18/6	0/17/8	0/15/10
Axillary	SC	11/14/0	7/18/0	4/20/1	2/21/2	2/20/3	2/20/3	1/18/6
	IS	3/21/1	2/22/1	1/22/2	1/21/3	1/19/5	1/18/6	0/16/9
$P < 0.05$		a,c						
	AX	2/23/0	1/24/0	0/19/6	0/19/6	0/19/6	0/16/9	0/13/12
Musculocutaneous	SC	11/14/0	5/19/1	4/19/2	2/20/3	2/19/4	1/19/5	1/16/8
	IS	2/22/1	1/23/1	1/22/2	1/21/3	0/20/5	0/19/6	0/16/9
$P < 0.05$		a,c						
	AX	2/23/0	1/22/2	0/17/8	0/17/8	0/17/8	0/14/11	0/11/14
Radial	SC	10/15/0	5/19/1	4/19/2	2/20/3	1/19/5	1/19/5	1/15/9
	IS	3/21/1	2/22/1	1/22/2	1/20/4	0/19/6	0/19/6	0/15/10
$P < 0.05$		a,c		a,b				
	AX	2/23/0	2/21/2	0/17/8	0/17/8	0/16/9	0/13/12	0/10/15
Median	SC	11/14/0	5/20/0	3/21/1	1/22/2	0/22/3	0/21/4	0/16/9
	IS	4/20/1	3/21/1	2/22/1	2/21/2	2/19/4	2/19/4	2/16/7
$P < 0.05$		a,c		a,b			a,b	a,b
	AX	2/23/0	2/21/2	0/17/8	0/15/10	0/15/10	0/12/13	0/10/15
Ulnar	SC	11/14/0	5/20/0	4/20/1	2/21/2	1/20/4	1/20/4	0/16/9
	IS	5/19/1	4/20/1	4/20/1	3/19/3	3/18/4	2/19/4	1/17/7
$P < 0.05$		a		a,b	a,b		a,b	a,b
	AX	3/22/0	2/21/2	0/17/8	0/16/9	0/15/10	0/12/13	0/9/16
Medial Antebrachial Cut	SC	12/13/0	7/17/1	5/18/2	3/20/2	2/20/3	1/21/3	0/18/7
	IS	5/19/1	4/20/1	3/21/1	3/20/2	3/19/3	3/17/5	3/14/8
$P < 0.05$		a,c		a,b	a,b	a,b	a,b	a,b
	AX	2/23/0	1/24/0	0/19/6	0/17/8	0/17/8	0/14/11	0/11/14
Medial Brachial Cut	SC	13/12/0	7/18/0	6/18/1	3/20/2	2/20/3	2/19/4	1/17/7
	IS	8/16/1	8/16/1	7/17/1	7/16/2	6/17/2	6/16/3	5/13/7
$P < 0.05$		a,b		a,b	a,b	a,b	a,b	a,b
	AX	14/11/0	14/11/0	13/7/5	13/6/6	13/5/7	13/5/7	13/4/8
Intercostobrachial	SC	17/8/0	12/13/0	11/13/1	9/15/1	8/15/2	8/14/3	7/13/5
	IS	16/8/1	15/9/1	14/10/1	14/9/2	13/10/2	13/9/3	12/8/5
$P < 0.05$					a,b	a,b		

Number of patients with “sharp/dull/no sensation” to pinprick are shown.
$P < 0.05$ (a: AX versus SC, b: AX versus IS, c: SC versus IS)

Table 4. Development of motor block with axillary (AX), supraclavicular (SC), or interscalene (IS) approach for brachial plexus block.

Nerves		3 min	6 min	9 min	12 min	15 min	18 min	30 min
	AX	17/8/0	16/8/1	15/9/1	15/7/3	15/7/3	15/5/5	15/3/7
Dorsal Scapular	SC	14/11/0	6/17/2	4/16/5	1/17/7	1/14/10	1/14/10	1/13/11
	IS	8/14/3	5/12/8	3/13/9	3/10/12	3/9/13	3/9/13	3/8/14
P < 0.05			a,b	a,b	a,b	a,b	a,b	a,b
	AX	7/18/0	4/20/1	0/16/9	0/14/11	0/13/12	0/11/14	0/9/16
Axillary	SC	14/11/0	6/17/2	4/17/4	1/17/7	1/14/10	1/14/10	1/12/12
	IS	8/14/3	5/12/8	3/14/8	3/12/10	3/11/11	3/11/11	3/9/13
P < 0.05		a,c	b,c					
	AX	7/18/0	4/20/1	0/15/10	0/11/14	0/10/15	0/10/15	0/8/17
Musculocutaneous	SC	16/9/0	7/16/2	5/16/4	2/18/5	1/17/7	1/17/7	1/15/9
	IS	8/15/2	5/14/6	3/14/8	3/12/10	3/12/10	3/11/11	3/9/13
P < 0.05		a,c						
	AX	7/17/1	4/19/2	0/15/10	0/11/14	0/10/15	0/10/15	0/9/16
Radial	SC	15/9/0	7/16/2	5/16/4	2/18/5	1/17/7	1/17/7	0/15/10
	IS	8/15/2	5/14/6	3/14/8	3/12/10	3/12/10	3/11/11	3/10/12
P < 0.05								
	AX	8/17/0	5/20/0	1/16/8	1/13/11	1/12/12	1/10/14	1/8/16
Median	SC	18/7/0	12/12/1	8/15/2	6/17/2	2/20/3	2/20/3	1/18/6
	IS	12/12/1	9/15/1	6/17/2	6/16/3	5/17/3	5/17/3	3/15/7
P < 0.05		a,b		a,b	a,b	a,b	a,b	a,b
	AX	11/14/0	7/18/0	2/15/8	2/12/11	2/11/12	2/9/14	2/7/16
Ulnar	SC	18/7/0	12/12/1	8/15/2	6/17/2	2/20/3	2/20/3	1/16/8
	IS	12/12/1	9/15/1	6/17/2	6/16/3	5/17/3	5/17/3	3/16/6
P < 0.05				a,b	a,b	a,b	a,b	a,b

Number of patients with motor power as "normal contraction /reduced contraction/ no contraction" of the hand and arm are shown.
P < 0.05 (a: AX versus SC, b: AX versus IS, c: SC versus IS)

9th, 12th, 18th, and 30th minutes in the ulnar nerve (P = 0.025, P = 0.007, P = 0.022, P = 0.018, and P = 0.018), at the 3rd, 9th, 18th, and 30th minutes in the median nerve (P = 0.017, P = 0.01, P = 0.015, and P = 0.015), at the 3rd and 9th minutes in the radial nerve (P = 0.023, and P = 0.01), and only at the 3rd minute in the musculocutaneous nerve (P = 0.004). At the 30th minute, the adequate sensory block rates in the musculocutaneous, radial, median and ulnar nerves in groups AX, SC, and IS were found to be 100%, 100%, 100%, and 100%; 96%, 96%, 100%, and 100%; and 100%, 100%, 92%, and 96%, respectively (Table 3).

In terms of motor block, statistically significant differences among the 3 groups were observed at the 3rd minute in the musculocutaneous and median nerves (P = 0.02 and P = 0.038), from the 9th minute until the 30th minute in the median and ulnar nerves (P = 0.023, P = 0.009, P = 0.007, P = 0.001, P = 0.001 and P = 0.046, P = 0.015, P = 0.009, P = 0.001, P = 0.001). At the 30th minute, the adequate motor block rates in the musculocutaneous, radial, median, and ulnar nerves in groups AX, SC, and IS were found to be 100%, 100%, 96% and 92%; 96%, 100%, 96%, and 96%, and 88%, 88%, 88%, and 88%, respectively (Table 4).

Statistically significant differences were observed between AX and SC groups, and between AX and IS groups in terms of sensory block at all measurement times, except the 6th minute, in the medial antebrachial cutaneous and medial brachial cutaneous nerves, and at the 12th and 15th minutes in the intercostobrachial nerve (P = 0.04 and P = 0.026) (Table 3). At the 30th minute, the adequate sensory block rates in the medial antebrachial cutaneous, medial brachial cutaneous, and intercostobrachial nerves in groups AX, SC, and IS were found to be 100%, 100% and 48%; 100%, 96% and 72%; and 88%, 80%, and 52%, respectively. The adequate sensory block rate in intercostobrachial nerve was generally low.

Discussion

Brachial plexus approaches have usually been considered in terms of their reliability in blocking various nerves supplying the upper extremity. The sensory and motor innervations of the upper extremity were clinically important as they determine which cutaneous nerve distributions within a surgical site require conduction block, which terminal nerve branches require supplementation for an incomplete block, and the existence and distribution of preoperative and postoperative neurological deficits (8). In brachial plexus block, in order to improve efficacy, not only a variety of agents and volumes of local anesthetic but also different methods for injection have been described (9). In the present study, we chose axillary, supraclavicular, and interscalene approaches to perform brachial plexus block.

Axillary injection produces reliable block of the medial aspect of the arm, forearm, and hand, but may fail to anesthetize the lateral aspect of the limb. The supraclavicular approach is usually thought to provide the most complete block, regularly producing anesthesia of the entire upper arm, with the exception of the skin over the shoulder. Interscalene injection reliably anesthetizes the outer aspect of the arm, but only blocks the ulnar nerve in approximately 50% of cases. (1,2,7,10,11).

When brachial plexus block is performed for surgery, sensory block is emphasized more and the lack of motor block or partial block is not always considered a disadvantage for the surgical procedure (1). Thus, we discussed the block of the nerves through various approaches in detail with respect to the sensory block achieved rather than the motor block achieved.

The 99% success rate reported in the literature (12) using axillary block for musculocutaneous and radial nerves is parallel to the rate obtained in our study. Cockings et al. (12) reported that the high success rate was associated with high-dose local anesthetic use, and increased volume was expected to provide proximal diffusion. However, Pere et al. (13) reported the importance of sufficient diffusion of local anesthetic into the proximal area to achieve successful block of axillary and musculocutaneous nerves through axillary approach. In a study with axillary block by use of 50 mL 1.25% Mepivacaine, Quinlan et al. (14) evaluated each of the terminal nerves of the brachial plexus, similar to the present study, and reported a success rate of up to 100% in achieving sensory block.

According to the success rates reported by Schroeder et al. (15) for interscalene, supraclavicular, and axillary blocks for elbow surgery, adequate surgical anesthesia was present in 89% of axillary, 78% of supraclavicular, and 75% of interscalene blocks. Based on these results, an axillary approach to the brachial plexus may be successfully used for elbow surgery. Axillary block of brachial plexus is the most commonly used technique in different types of surgical procedures on elbow, forearm, and hand as a result of its ease of application and fewer side effects (8).

In supraclavicular approach, because the trunks of brachial plexus are too dense at the point where they cross the first rib, 25 mL local anesthetic solution is sufficient to achieve a complete brachial plexus block. In performing this block, if no paresthesia develops, larger volumes are needed (40-50 mL). In fact, delayed onset or patchy anesthesia may be encountered (16). The supraclavicular approach provides greater extent of block than the axillary block as it includes the musculocutaneous and the axillary nerves. In this technique, sensory block of the dermal innervation areas of the musculocutaneous and radial nerves followed by the median and ulnar nerves has been reported to have a rapid onset (17). Supraclavicular approach results in a certain degree of cervical plexus sensory anesthesia as well as the anesthesia of brachial plexus. Literature reports that the axillary, musculocutaneous, radial, median and ulnar nerves are blocked more homogeneously and at a higher rate through supraclavicular approach (16), which is supportive of our results.

Knoblanche (18) used a lower local anesthetic volume and more caudal points of injection in supraclavicular block, which may help to explain the lower incidence of cervical plexus anesthesia that developed. In our study, the occipital minor and transverse colli nerves were adequately blocked in 12% and 20% of the patients by supraclavicular approach, and in 72% and 84% of the patients by the interscalene approach, respectively. However, these nerves were not affected by the axillary approach.

In the interscalene approach, total C_3 and C_2 dermatomal sensory anesthesia was achieved at a dose of 40 mL. In contrast, with 20 mL, dermatomal sensory anesthesia with only partial C_3 block and no C_2 block developed **(**16**)**. To ensure adequate cervical sensory anesthesia for shoulder surgery, Urmey et al. (19) initially used larger volumes (34-52 mL) in the interscalene approach. However, Urmey and Gloeggler (20) subsequently determined total C_3 dermatomal anesthesia in half of the patients who were subjected to a block with 20 mL and partial C_3 dermatomal anesthesia in the other half. This conclusion was compatible with the results obtained by Winnie (21). Although we used a volume of 30-35 mL, calculated as per the formula in our study, the results we obtained seemed to be approximate to the results obtained in Winnie's study (21) with the volume of 40 mL.

Dewees et al. (22) compared interscalene block to supraclavicular block. They associated the latter approach with a higher incidence of complete sensory and motor block of the radial, median, ulnar, and musculocutaneous nerves (92% versus 74%, respectively) (1). In our study, the sensory and motor block rates in brachial plexus block through supraclavicular approach were similar (96%-100%), whereas the sensory block rate was 92%-100% and motor block rate was 88% through the interscalene approach.

The intercostobrachial nerve is blocked separately when anesthesia is needed for the medial upper arm or axilla or for anterior portal placement during arthroscopic shoulder surgery (2). Alternative approaches include local infiltration or T_{1-2} paravertebral block. Supplementation of this nerve is necessary because there are no convincing data confirming that any of the approaches to the brachial plexus consistently anesthetize the T_{1-2} nerve roots (2,9). In our study, no block developed in the intercostobrachial nerve in 28%-52% of the patients in none of the 3 approaches. The lack of block in at least half of the patients with all approaches was in conformity with the literature findings.

In a study by Lanz et al. (7), which is very similar to our study, 50 mL of 0.5% bupivacaine was used in all the cases. They reported that when brachial plexus block was performed, the extent of the block depends on the approach used. Accordingly, we used less anesthetics (30-35 mL) in our study, and adequate sensory and motor block rates were reported for brachial plexus and cervical plexus obtained were similar to those obtained in the study mentioned above.

We evaluated axillary, supraclavicular, and interscalene approaches used in brachial plexus block for sensory and motor block quality provided at the end of the 30th minute. However, there may be a limitation in the present study. Since it would be an inappropriate practice, we did not randomize our patients to axillary, supraclavicular, or interscalene groups. We rather performed brachial plexus according to the site on which surgery will be conducted.

In conclusion, when brachial plexus block is performed for a planned surgery, onset, quality, and extent of the sensory and motor blocks of brachial plexus nerve, and partially cervical plexus nerve, depend on the approach adopted. In order to obtain adequate sensory and motor block with the least additional analgesic and anesthetic requirement, the innervation regions of all the nerves belonging to brachial plexus and partially to cervical plexus, and to what extent these regions can be affected through the approaches we apply should be well known. In this way, the choice of the most suitable approach for the site of surgery and the patient might be helpful in preventing time loss and decreasing possible complications due to the procedure.

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