



Incidence of Neurological Injury After Ultrasound-Guided Interscalene Brachial Plexus Nerve Block

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Abstract

Purpose: The purpose of this study was to find the incidence of neurological injury after Ultrasound-Guided Interscalene Brachial Plexus Nerve Block.

Methodology: This study was a retrospective chart review of 1500 patients undergoing shoulder surgery with single-shot US-ISB from January 2017 to May 2021. The general anesthesia prior to the US-guided ISB procedure was standardized by expert anesthesiologists. Neurological postoperative complications were evaluated at 36hrs, 48 hours, about 2 weeks, 1 month, 3 months, 6 months, and up to resolution after operation.

Results: The study results showed that paresthesia was 5.9%, 2.7%, 2.1%, 0.5%, 0.1% and 0.1% at 36 hours, 48 hours, two weeks, one month, two months and six months respectively. Further the result showed that muscular weakness was 5.9%, 2.7%, 1.3%, 0.6%, 0.3% and 0.1% at 36 hours, 48 hours, after 2 weeks, 1 month, 3 months and 6 months respectively. Also hyperesthesia was 1.9%, 1.3%, 0.8%, 0.8%, 0.5%, 0.2% and 0.1% at 36 hours, 48 hours, 2 weeks, 1 month, 3 months and 6 months respectively.

Conclusion: According to the study, paresthesia, muscle weakness and hyperesthesia following an ultrasound-guided interscalene brachial plexus block were negligible after six months. Even though paresthesia was affected 5.9% of the study population at 36 hours after surgery, it was significantly reduced to 0.1%. Also muscle weakness was affected 5.9% of the study participants at 36 hours after surgery and it was reduced to 0.1% after 6 months and hyperesthesia affected 1.9% of the study population at 36 hours and it was also reduced to 0.1%. This study demonstrated that Interscalene brachial plexus block was an effective method of analgesia for upper arm limb surgeries.

Keywords: Ultrasound-Guided Interscalene Brachial Plexus Nerve Block, Post-Operative Neurological Symptoms, Hemidiaphragmatic Paresis

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Introduction

The brachial plexus block (BPB) is a common method for administering anesthesia and pain relief to the upper extremities during surgical procedures. However, these procedures are not always risk-free and can cause a variety of complications, including brachial plexus injury (BPI). Damage to the nerves is a dire complication. The patient with BPI may experience only temporary, minor discomfort. However, persistent sensory or motor deficits

Interscalene brachial plexus block (ISB) is one of the most effective techniques for shoulder arthroscopic surgery anesthesia and postoperative analgesia. Ultrasound guidance, in contrast to anatomical landmark and paresthesia techniques, can provide direct visualization of the target nerve, surrounding tissue, and injectate spread, and may increase patient safety by reducing nerve injury or other

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injury.¹⁻⁵



serious complications like local anesthetic systemic toxicity and pneumothorax.⁵

Many patients and surgeons choose general anaesthesia over a block or a combination of a block and general anaesthesia because they are unaware of the potential complications and fear the insertion of a syringe into the neck during ISB. Specifically, the most prevalent fallacy is that nerve blocks increase the risk of nerve injury. Ultrasound allows modest volumes of brachial plexus block to substantially reduce the incidence and severity of hemidiaphragmatic paresis (HDP), but has no effect on the incidence of postoperative neurologic symptoms (PONS).⁶

This study evaluated and reviewed the US-ISB-related safety of PONS in orthopaedic surgery patients in order to describe post-operative neurological symptoms, such as hemidiaphragmatic paresis and post-operative neurologic symptoms, after US-ISB.

Methodology

This was a retrospective analysis of 1500 patients who received humerus and shoulder surgery/arthroscopic surgery or open surgery, under ultrasound-guided ISB performed between June 2017 and August 2021 after obtaining the Institutional Review Board approval. The study conducted in Department of Anaesthesiology, Government Medical College, Kottayam. The patient medical records were reviewed for demographic information, American Society of Anesthesiologists physical status classification, underlying diseases, operative time, anesthetic time, type of surgical procedure, local anesthetics used for ISB, and postoperative complications.

1. Basic demographic characteristics

Variable	Characteristics	n	%
Age	18 to 30yrs	338	22.5
	31 to 45yrs	414	27.6
	46 to 60yrs	417	27.8
	60 yrs above	331	22.1
Mean and SD Age = 45.53±16.14 (Minimum age 18 and maximum 75yrs)			
Gender	Female	713	47.5
	Male	787	52.5
BMI	Underweight	128	8.5
	Normal	847	56.5
	over weight	525	35
Mean and SD BMI and Weight = 22.9±3 and 61.8±15.8			
ASA-PS	Class I	779	51.9
	Class II	711	47.4
	Class III	10	0.7

To avoid double crush syndrome, patients with neurological disorders of the brachial plexus will be excluded from receiving ISB. In addition, because multiple sclerosis is a risk factor for brachial plexopathy, these patients will be excluded from ISB. Active infections at the block site, coagulopathy (international normalised ratio >2.0 according to our institution's criteria), severe chronic obstructive pulmonary disease (percent predicted forced expiratory volume in one second 50%), and contralateral phrenic nerve palsy as diagnosed by preoperative plain radiography will be excluded.

Patients with PONS after ISB were evaluated for a motor deficit (weakness) or sensory deficit (loss of feeling), such as hypoesthesia, which is defined as numbness; paresthesia, which is defined as an abnormal but not unpleasant sensation; and pain dysesthesia, which is defined as an unpleasant abnormal sensation.⁷ Following surgery, patients were evaluated 48 hours, 2 weeks, 1 month, 3 months, and 6 months later. In certain instances, patients were monitored until their symptoms improved. We determined if these PONS were linked to ISB or surgery.

Data coded and entered into MS EXCEL software and analysed, by IBM SPSS version 26. Descriptive data are presented as numbers (%) or mean ± standard deviation.

Result

A total of 1500 study subjects' medical records retrospectively reviewed and analyzed in this study. The demographic and surgical data are summarized in Table 1 and 2.



Co morbidities	No Comorbidities	777	51.8	
	HTN	283	18.9	
	Bronchial Asthma	148	9	
	Diabetes	146	9.7	
	CAD	106	7.1	
	DM,HTN	9	0.6	
	SEIZURE	26	1.7	
	HTH	5	0.3	
Total		1500	100%	
Variable s	Minimum	Maximum	Mean	Std. Deviation
Heart rate(b/m)	54	95	75	11.5
DBP(mm/ hg)	50	99	74.8	14.2
SBP(mm/ hg)	80	149	117	14.8

The age group of the study subjects with the highest percentage was 31 to 45 years and 46 to 60 years (27.6% and 27.8%), followed by 18 to 30 years and 60 years and older (22.5% and 22.1%), respectively. The mean ± SD of the study subject's age was 45.53 ± 16.14 (Minimum age 18 and maximum age 75 years). More than 52.5% of study participants were men. While the majority of research participants had normal BMIs (56.5%), 35 % of them were overweight and 8.5% of them were underweight. ASA-PS class I included 51.9% of

the study's participants, class II were 47.4% and 0.7% of them were in class III. The majority of the study participants had no co-morbid conditions; however, 18.9% of them had HTN, which was followed by DM (9.7%), bronchial asthma (9%), coronary artery disease (7.1%), seizures (1.7%), DM, HTN (0.6), HTH (0.3%) respectively.

The patients in the study had a mean heart rate of 75 ± 11.5, a mean systolic blood pressure of 117 ± 14.8, and a mean diastolic blood pressure of 74.8 ± 14.2.

2. Surgical characteristics

Variable	Characteristics	n	%	
Type of anesthetics	0.5% LB + D	705	47	
	0.5% RD + D	485	32.3	
	0.5% RD	82	5.5	
	0.5% LB	228	15.2	
Surgical procedure type	ORIF	1500	100	
	Total	1500	100%	
Variable s	Minimum	Maximum	Mean	SD
Duration analgesia hrs	8	18	13	3.1
Volume of local anaesthetics (ml)	25	25	25.00	0.000
Operative time (hrs)	2	3	2.49	0.500

The majority of the study individuals were given 0.5% levobupivacaine + dexamethasone (0.5% LB + D) anesthetics (47%), followed by 0.5% Ropivacaine + dexamethasone (0.5% RD + D) (32.3%), 0.5% Ropivacaine (0.5% RD) (5.5%), and 0.5% levobupivacaine (0.5% LB) (15.2%), respectively. All of the study

participants had surgery for a fractured humerus (ORIF).

The mean volume of local anesthetic utilized was 25 ml, the mean operational time in hours was 2.48 ± 0.5, and the mean SD duration of analgesia in hours was 13 ± 3.1

Neurological symptoms

Neurological symptoms	Time appeared	n	%
Paresthesia	36 hours	88	5.9
	48 hours	41	2.7
	2 weeks	18	2.1
	1 month	7	0.5
	3 months	1	0.1
	6 months	1	0.1
Muscle weakness	36 hours	88	5.9
	48 hours	41	2.7
	2 weeks	19	1.3



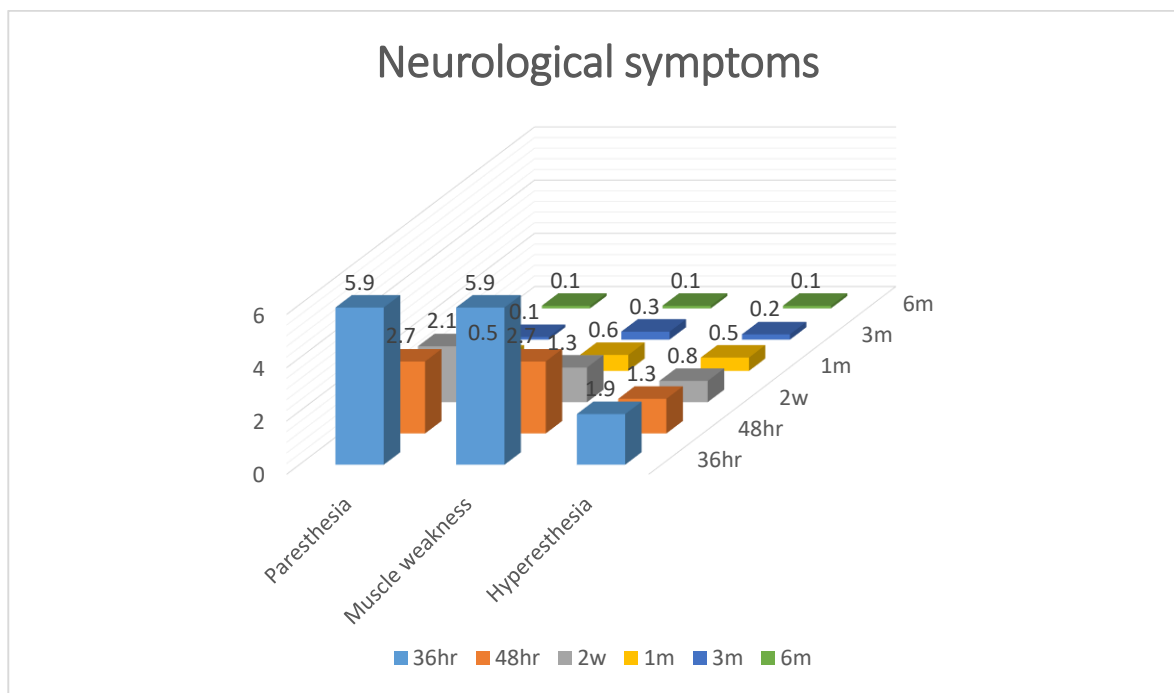
	1 month	9	0.6
	3 months	5	0.3
	6 months	2	0.1
Hyperesthesia	36 hours	28	1.9
	48 hours	20	1.3
	2 weeks	12	0.8
	1 month	8	0.5
	3 months	3	0.2
	6 months	1	0.1

paresthesia, which was reported by 5.9% at 36 hours and 2.7% at 48 hours. After two weeks, 2.1% of the participants in the research still had paresthesia; after one month, 0.5% persisted; after two months, 0.1% persisted; and after six months, 0.1% persisted.

5.9% of the people who participated in the research study reported having muscular weakness after 36 and 2.7% at 48 hours; 1.3% of the people who participated in the research study still had muscle weakness after 2 weeks;

0.6% had muscle weakness after 1 month; 0.3% had muscle weakness at 3 months; and 0.1% had muscle weakness at 6 months.

At 36 hours, 1.9% of the study subjects reported having hyperesthesia, while 1.3% of them reported having it at 48 hours. After 2 weeks, 0.8% of the study subjects still experienced hyperesthesia; after 1 month, 0.5% still showed; after 3 months, 0.2% still showed; and after 6 months, 0.1% still showed. (See Table 3 and Figure 1).



Discussion

The interscalene block (ISB), which could be used alone or in combination with general anesthesia, was initially proposed in 1970.⁸ ISBs are gaining prominence in shoulder surgery as a result of their ability to assuage intraoperative and postoperative discomfort and relax muscles, as a result of technological advances in surgical instruments and techniques. ISB has several advantages over general anesthesia, including the absence of

airway manipulation, the avoidance of postoperative nausea and vomiting, the low risk of postoperative delirium, a decrease in perioperative opioid consumption, and reduced medical costs.⁹⁻¹¹

Borgeat et al.⁸ examined prospectively the acute and nonacute complications of interscalene block and shoulder surgery. 521 adults scheduled to undergo shoulder surgery with an ISB were included in this prospective



study. All patients adhered to a standardized ISB protocol. There were reports of acute complications. Patients were evaluated for paresthesias, dysesthesias, non-surgical pain, and muscular weakness one, three, six, and nine months after surgery, and were observed daily for ten days. At 1 or 3 months, electromyography was utilized to evaluate the persistence of paresthesias, dysesthesias, non-surgical pain, and muscular paralysis. After nine months, the final assessment was performed. The study showed that a 0.4% incidence of severe short-term and long-term complications is associated with interscalene brachial plexus blocks performed using a standardized technique, material, and medications. In cases of persistent paresthesia, dysesthesia, or pain unrelated to surgery following ISB, it may be necessary to rule out sulcus ulnaris syndrome, carpal tunnel syndrome, or complex regional pain syndrome, as specific treatment may be required.

Candido et al.¹³ determined the incidence, distribution, and resolution of neurologic sequelae, as well as their association with anesthetic, surgical, and patient factors, in 693 consecutive adult patients undergoing shoulder or upper arm surgery, or both. Following a standard ISB, anesthesia, hypesthesia, paresthesias, pain/dysesthesias, and motor impairment were evaluated at 24 h, 48 h, and 2 and 4 weeks. Symptomatic patients were monitored until resolution. Diagnostic evaluations were conducted on subjects with a pain or distress rating of >3 on a scale of 10 and those with motor or extending sensory symptoms. 660 participants completed the four-week follow-up period. The study demonstrated that neurologic sequelae following a single injection of ISB containing epinephrine primarily entail modest transient sensory symptoms. Orebaugh et al.¹³ conducted a retrospective study. During the 28-month study period, there were 5436 consecutive peripheral noncatheter block cases (interscalene, axillary, femoral, sciatic, and popliteal), 3290 of which were guided by landmark-nerve stimulation and 2146 of which were guided by ultrasound-nerve stimulation. Eight adverse outcomes, including five convulsions and three nerve lesions, occurred in patients who received blocks guided by landmark-nerve stimulation technique. In the ultrasound-nerve stimulation group, such

incidents did not occur. The risk of seizures was statistically significant ($P = 0.044$, Fisher exact test) when comparing four brachial plexus block-related seizures with landmark guidance to none with ultrasound guidance. With lower extremity blocks, there was no difference in the incidence of neurologic impairment or the number of convulsions between the two groups. The study showed that high-resolution ultrasonography offers potential benefits for administering peripheral nerve blockade. The significant difference in main central nervous system local anesthetic toxicity observed in this investigation supports the use of ultrasound guidance in conjunction with peripheral nerve stimulation in academic ambulatory anaesthesia practices for brachial plexus peripheral nerve blockade.

The primary objective of the present study was to determine the incidence of neurologic injury following ultrasound-guided interscalene brachial plexus nerve block. The present study revealed that 5.9% of patients at 36 hours and 2.8% at 48 hours reported paresthesia. After two weeks, 2.1% of the participants in the study still experienced paresthesia; after one month, 0.5%; after two months, 0.1%; and after six months, 0.1%. 5.9% of the participants in the study reported muscle weakness after 36 hours and 2.7% after 48 hours; 1.3% of the participants in the study still had muscle weakness after 2 weeks; 0.6% after 1 month; 0.3% after 3 months; and 0.1% after 6 months. At 36 hours, 1.9% of the study participants reported hyperesthesia, while only 1.3% did so at 48 hours. After two weeks, 0.8% of the study participants still exhibited hyperesthesia; after one month, 0.5%; after three months, 0.2%; and after six months, 0.1%.

Jeong et al.¹⁶ carried out a retrospective examination of neurological complications following ultrasound-guided interscalene block for arthroscopic shoulder surgery. From January 2010 to May 2015, 668 patients who underwent shoulder surgery with single-shot US-ISB underwent a retrospective chart review. Expert anesthesiologists standardized the general anesthetic administered before the ISB procedure guided by the United States. Neurological complications following surgery were evaluated at 48 hours, two weeks, one



month, three months, six months, and until resolution. Three patients (0.4% of the total) developed hemidiaphragmatic paresis (HDP), which was presumably caused by US-ISB and resolved within 24 hours. Two patients developed likely US-ISB-related sensory symptoms: paresthesia at the tip of the thumb/index finger, which resolved in two weeks, and hypoesthesia involving the posterior auricular nerve, which resolved in six months. Hypoesthesia (n = 28, 4.6%), pain (n = 2, 0.3%), and motor impairment (n = 2, 0.3%) were unlikely to be associated with US-ISB. The study concluded that the incidence of HDP and neurological complications related to transient minor sensory symptoms following US-ISB shoulder arthroscopy was 0.4% and 0.3%, respectively, but that the complications resolved spontaneously.

According to Borgeat et al.⁸, the incidence of persistent paresthesia, dysesthesia, or pain unrelated to surgery was 7.9% at 1 month, 3.9% at 3 months, 0.9% at 6 months, and 0.2% at 9 months at the time of ISB using a nerve stimulator and a perineural catheter. Candido et al.¹³ observed an incidence rate of 4.4% for PONS related to the ISB procedure; nine cases (1.3%) developed side effects at the ISB site, such as the phalanx of the thumb/index finger, and seven cases (1%), based on symptom distribution, developed side effects related to the posterior auricular nerve, all of which resolved within 2–12 weeks. In this present study the incidence for PONS was lower than that reported in other previous above ISB studies. In the present study Paresthesia was 5.9% at 36 hours and 2.7% at 48 hours. After two weeks, 2.1% of the participants in the research still had paresthesia; after one month, 0.5% persisted; after two months, 0.1% persisted; and after six months, 0.1% persisted.

In the present study, 5.9% of the people who participated in the research study reported having muscular weakness after 36 and 2.7% at 48 hours; 1.3% of the people who participated in the research study still had muscle weakness after 2 weeks; 0.6% had muscle weakness after 1 month; 0.3% had muscle weakness at 3 months; and 0.1% had muscle weakness at 6 months.

In the present study, at 36 hours, 1.9% of the

study subjects reported having hyperesthesia, while 1.3% of them reported having it at 48 hours. After 2 weeks, 0.8% of the study subjects still experienced hyperesthesia; after 1 month, 0.5% still showed; after 3 months, 0.2% still showed; and after 6 months, it was reduced to 0.1%.

Conclusion

According to the study, paresthesia, muscle weakness and hyperesthesia following an ultrasound-guided interscalene brachial plexus block were negligible after six months. Even though paresthesia was affected 5.9% of the study population at 36 hours after surgery, it was significantly reduced to 0.1%. Also muscle weakness was affected 5.9% of the study participants at 36 hours after surgery and it was reduced to 0.1% after 6 months and hyperesthesia affected 1.9% of the study population at 36 hours and it was also reduced to 0.1%. Though paresthesia, muscle weakness and hyperesthesia are common complications of nerve block, this study showed that the incidence of complications in the study population under Ultrasound-Guided Interscalene Brachial Plexus Nerve Block was drastically reduced after 6 months of the surgeries. This study showed that USG Interscalene brachial plexus nerve block was an effective method of analgesia for upper arm limb surgeries.

Conflict of interest: Nil

References

- Urban MK, Urquhart B. Evaluation of brachial plexus anesthesia for upper extremity surgery. *RegAnesth.* 1994;19:175–182. [PubMed] [Google Scholar]
- Fanelli G, Casati A, Garancini P, Torri G. Nerve stimulator and multiple injection technique for upper and lower limb blockade: failure rate, patient acceptance, and neurologic complications. Study Group on Regional Anesthesia. *AnesthAnalg.* 1999;88:847–852. [PubMed] [Google Scholar]
- Porzionato A, Montisci M, Manani G. Brachial plexus injury following subclavian vein catheterization: a case report. *J ClinAnesth.* 2003;15:582–586. [PubMed] [Google Scholar]
- Jernigan WR, Gardner WC, Mahr MM, Milburn JL. Use of the internal jugular vein for placement of central venous catheter. *SurgGynecol Obstet.* 1970;130:520–524.
- McNaught A, Shastri U, Carmichael N, Awad IT, Columb M, Cheung J, et al. Ultrasound reduces the minimum effective local anaesthetic volume compared with peripheral nerve stimulation for interscalene block. *Br J Anaesth* 2011; 106: 124-30. PMID: 10.1093/bja/aeq306. PMID: 21059701.



- Neal JM. Ultrasound-guided regional anesthesia and patient safety: update of an evidence-based analysis. *RegAnesth Pain Med* 2016; 41: 195-204. PMID: 10.1097/AAP.0000000000000295. PMID: 26695877.
- Neal JM. Ultrasound-guided regional anesthesia and patient safety: update of an evidence-based analysis. *RegAnesth Pain Med* 2016; 41: 195-204. PMID: 10.1097/AAP.0000000000000295. PMID: 26695877.
- Borgeat A, Ekatothramis G, Kalberer F, Benz C. Acute and nonacute complications associated with interscalene block and shoulder surgery: a prospective study. *Anesthesiology* 2001; 95: 875-80. PMID: 10.1097/00000542-200110000-00015. PMID: 11605927.
- Winnie A.P. Interscalene brachial plexus block. *AnesthAnalg*. 1970;49:455-466.
- Ravi B., Pincus D., Choi S., Jenkinson R., Wasserstein D.N., Redelmeier D.A. Association of duration of surgery with postoperative delirium among patients receiving hip fracture repair. *JAMA Netw Open*. 2019;2:e190111. doi: 10.1001/jamanetworkopen.2019.0111.
- Lehmann L.J., Loosen G., Weiss C., Schmittner M.D. Interscalene plexus block versus general anaesthesia for shoulder surgery: a randomized controlled study. *Eur J OrthopSurgTraumatol*. 2015;25:255-261. doi: 10.1007/s00590-014-1483-3.
- Gonano C., Kettner S.C., Ernstbrunner M., Schebesta K., Chiari A., Marhofer P. Comparison of economical aspects of interscalene brachial plexus blockade and general anaesthesia for arthroscopic shoulder surgery. *Br J Anaesth*. 2009;103:428-433. doi: 10.1093/bja/aep173.
- Candido KD, Sukhani R, Doty R Jr, Nader A, Kendall MC, Yaghmour E, Kataria TC, McCarthy R. Neurologic sequelae after interscalene brachial plexus block for shoulder/upper arm surgery: the association of patient, anesthetic, and surgical factors to the incidence and clinical course. *AnesthAnalg*. 2005 May;100(5):1489-1495. doi: 10.1213/01.ANE.0000148696.11814.9F. PMID: 15845712.
- Orebaugh SL, Williams BA, Vallejo M, Kentor ML. Adverse outcomes associated with stimulator-based peripheral nerve blocks with versus without ultrasound visualization. *RegAnesth Pain Med*. 2009 May-Jun;34(3):251-5. doi: 10.1097/AAP.0b013e3181a3438e. PMID: 19587625.
- Riazi S, Carmichael N, Awad I, Holtby RM, McCartney CJ. Effect of local anaesthetic volume (20 vs 5 ml) on the efficacy and respiratory consequences of ultrasound-guided interscalene brachial plexus block. *Br J Anaesth*. 2008 Oct;101(4):549-56. doi: 10.1093/bja/aen229. Epub 2008 Aug 4. PMID: 18682410.
- Jeong, Ji & Kim, Youn & Woo, Jae-Hee & Kim, Chi & Chae, Ji. (2018). A retrospective analysis of neurological complications after ultrasound guided interscalene block for arthroscopic shoulder surgery. *Anesthesia and Pain Medicine*. 13. 184-191. 10.17085/apm.2018.13.2.184.
- Melnyk V, Ibinson JW, Kentor ML, Orebaugh SL. Updated retrospective single-center comparative analysis of peripheral nerve block complications using landmark peripheral nerve stimulation versus ultrasound guidance as a primary means of nerve localization. *J Ultrasound Med* 2018;37:2477-2488.
- Yeniocak T, Canbolat N. Retrospective Analysis of Ultrasound-Guided Infraclavicular Block: Effect of Experience of Anesthesiologists on Volume of Local Anesthetic Administered. *Pain Res Manag*. 2019 May 6;2019:4846956. doi: 10.1155/2019/4846956. PMID: 31198476; PMCID: PMC6526514.
- Takayama K, Shiode H, Ito H. Ultrasound-guided interscalene block anesthesia performed by an orthopedic surgeon: a study of 1322 cases of shoulder surgery. *JSES Int*. 2021 Oct 12;6(1):149-154. doi: 10.1016/j.jseint.2021.08.008. PMID: 35141690; PMCID: PMC8811386.

