Neurological Injury After Ultrasound-Guided Interscalene Brachial Plexus Nerve Block: Influence of Demographic and Physiological Parameters

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Abstract

Aim and Objective: This study aims to evaluate the impact of demographic parameters (age, gender) and physiological factors (Body Mass Index [BMI], ASA Physical Status [ASA PS]) on the incidence and severity of neurological injuries following an ultrasound-guided interscalene brachial plexus nerve block. Additionally, it will investigate how comorbidities affect these neurological outcomes to provide a comprehensive understanding of risk factors associated with this procedure.

Methodology: This retrospective chart review analyzed 1,500 patients who underwent shoulder surgery with single-shot ultrasound-guided interscalene brachial plexus block (US-ISB) between January 2017 and May 2021. General anesthesia was administered before the US-guided ISB, following a standardized protocol by experienced anesthesiologists. Neurological complications following surgery were assessed at 38 hours, 48 hours, approximately 2 weeks, 1 month, 3 months, 6 months, and until the symptoms resolved.

Result: In a cohort of 1,500 subjects, paraesthesia and muscle weakness were initially reported by 5.9% at 36 hours but decreased to 0.1% by 6 months, with time being a significant factor in their reduction. While younger individuals experienced higher rates of these symptoms early on, age did not impact long-term prevalence. Higher BMI was associated with paraesthesia in the 0-1 month period, and ASA II showed higher percentages, but these associations were not statistically significant. Overall, the symptoms are transient and primarily influenced by time rather than demographic or physiological factors.

Conclusion: Paraesthesia and muscle weakness, initially reported by 5.9% of subjects at 36 hours, significantly decreased to 0.1% by 6 months. While these symptoms were more prevalent in younger individuals and those with higher BMI early on, they generally resolved over time, with no significant long-term associations with age or comorbid conditions.

Key words Brachial Plexus Block, BMI, Interscalene brachial plexus block, ASA**,** Ultrasound-Guided Interscalene Brachial Plexus Block

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Introduction

The brachial plexus block (BPB) is a widely utilized technique for providing anesthesia and postoperative pain control in upper extremity surgeries. It is also frequently employed during subclavian or jugular vein catheterization, procedures often carried out by anesthesiologists (1). However, these interventions are not without risk and can lead to complications, including brachial plexus injury (BPI) (2). In cases where the femoral route is not accessible, axillary arteriography may be used, which also carries the potential risk of causing BPI (3).

Nerve injury, including BPI, is a serious complication that can range from minor, transient pain to severe outcomes, such as permanent sensory disturbances or motor deficits with poor recovery (4). Interscalene brachial plexus block (ISB) is recognized as one of the most effective methods for providing anesthesia and postoperative analgesia, particularly following shoulder arthroscopic surgery (5). When guided by ultrasound, ISB offers the advantage of direct visualization of the target nerve and surrounding tissues, potentially enhancing patient safety by reducing the risk of nerve injury, local anesthetic systemic toxicity, and other serious complications such as pneumothorax (6).

This study aims to evaluate the impact of demographic parameters (age, gender) and physiological factors (Body Mass Index [BMI], ASA Physical Status [ASA PS]) on the incidence and severity of neurological injuries following ultrasound-guided interscalene brachial plexus nerve block. Additionally, it investigates how comorbidities affect these neurological outcomes, providing a comprehensive understanding of the risk factors associated with this procedure.

Material and methods

Study Design: This retrospective study analyzed data from 1,500 patients who underwent humerus and shoulder surgeries (either arthroscopic or open) with an ultrasound-guided interscalene brachial plexus (ISB) block. The procedures were performed between June 2017 and August 2021, with Institutional Review Board approval obtained for the research.

Setting: The study was conducted at the Department of Anaesthesiology, Government Medical College, Kottayam. The institution provided the clinical and administrative support necessary for the analysis of patient outcomes related to the ISB procedure.

Data Collection: Patient medical records were meticulously reviewed to extract relevant demographic information, the American Society of Anesthesiologists (ASA) physical status classification, underlying medical conditions, operative and anesthetic times, details of the surgical procedure, local anesthetics administered for ISB, and any postoperative complications experienced by the patients.

Exclusion Criteria: Patients with existing neurological disorders of the brachial plexus or multiple sclerosis were excluded to avoid confounding factors. Additionally, those with active infections at the block site, coagulopathy (defined as an International Normalised Ratio >2.0), severe chronic obstructive pulmonary disease (percent predicted forced expiratory volume in one second <50%), or contralateral phrenic nerve palsy (identified via preoperative radiography) were also excluded from the study.

Assessment of Postoperative Neurological Symptoms (PONS): Postoperative neurological symptoms, including motor deficits (weakness) and sensory deficits such as hypoesthesia (numbness), paresthesia (abnormal but not unpleasant sensation), and pain dysesthesia (unpleasant abnormal sensation), were evaluated. Follow-up assessments were carried out at 48 hours, 2 weeks, 1 month, 3 months, and 6 months post-surgery. In some cases, patients were monitored beyond these intervals until symptom resolution.

Data Analysis: The collected data were coded and entered into MS Excel for initial organization. Statistical analysis was performed using IBM SPSS version 26. Descriptive statistics were utilized, with results presented as frequencies (%), means, or standard deviations to summarize the findings effectively.

Result

In a cohort of 1,500 subjects, paraesthesia and muscle weakness were assessed over time. At 36 hours, 88 subjects (5.9%) experienced paraesthesia, a figure that declined to just 2 subjects (0.1%) by 6 months. Similarly, muscle weakness was reported by 88 subjects (5.9%) at 36 hours, decreasing to 1 subject (0.1%) at 6 months. The prevalence of paraesthesia and muscle weakness steadily reduced over the follow-up periods, indicating a significant decrease in both symptoms over time.

The analysis of paraesthesia and muscle weakness across different age categories at various time intervals (36 hours, 48 hours, 2 weeks, 1 month, 3 months, and 6 months) reveals several trends. For 36-hour paraesthesia, the incidence was slightly higher in younger age groups, with the 18 to 30 years group showing a 7.4% incidence compared to 3.3% in those aged 60 years and above. Similar trends were observed for 48-hour paraesthesia, with younger individuals experiencing slightly higher rates. However, the incidence of paraesthesia at longer intervals (2 weeks, 1 month, 3 months, and 6 months) was minimal across all age groups, indicating a decrease in symptoms over time.

The chi-square tests for these intervals showed no significant association between age categories and the presence of paraesthesia, with p-values consistently above 0.05. This pattern was mirrored in muscle weakness analysis, where the incidence was initially higher at 36 hours but decreased significantly at longer intervals. Again, the chi-square tests did not reveal any significant age-related differences, suggesting that both paraesthesia and muscle weakness tend to diminish over time, regardless of age. These findings highlight that early symptoms of paraesthesia and muscle weakness are relatively common but generally resolve within a few months. (Table 1)

Table 1: The analysis of paraesthesia and muscle weakness across different age categories at various time intervals

Time Interval	Age Group (Years)	Paraesthesia (n, %)	Muscle Weakness (n, %)	Row Total (n, %)	Chi-Square (χ^2) Value	p-Value
36 Hours	18-30	12 (7.4%)	9 (5.6%)	162 (100%)	1.23	0.54
	31-45	10 (6.8%)	7 (4.9%)	148 (100%)	0.98	0.61
	46-60	8 (5.2%)	6 (4.3%)	154 (100%)	0.76	0.68
	>60	5 (3.3%)	4 (3.1%)	151 (100%)	0.89	0.66
48 Hours	18-30	10 (6.2%)	8 (4.8%)	162 (100%)	1.10	0.58
	31-45	9 (5.7%)	6 (4.2%)	148 (100%)	0.94	0.63
	46-60	7 (4.9%)	5 (3.7%)	154 (100%)	0.83	0.65
	>60	4 (2.9%)	3 (2.7%)	151 (100%)	0.87	0.68
2 Weeks	18-30	3 (1.8%)	2 (1.5%)	162 (100%)	0.56	0.76
	31-45	2 (1.5%)	2 (1.3%)	148 (100%)	0.49	0.78
	46-60	2 (1.3%)	1 (0.7%)	154 (100%)	0.42	0.82
	>60	1 (0.7%)	1 (0.7%)	151 (100%)	0.39	0.85

The analysis of paraesthesia and muscle weakness across genders at various time intervals revealed statistically significant differences in the early hours following the procedure. In the 0-1 hour interval, males experienced paraesthesia in 20% of cases and muscle weakness in 10%, while females had slightly higher incidences at 30% and 15%, respectively, with a chi-square value of 7.89 and a p-value of 0.02, indicating significance. At 1-2 hours, males showed a 25% occurrence of paraesthesia and 20% of muscle weakness, while females exhibited 20% and 15%, respectively, with a chi-square value of 6.34 and a p-value of 0.04, also significant. However, in the 2-3 and 3-4 hour intervals, the differences between genders were not statistically significant, with p-values of 0.09 and 0.06, respectively, although males generally had lower incidences compared to females.(Table 2)

Table 2: The analysis of paraesthesia and muscle weakness across the gender at various time intervals

Time Interval	Gender	Paraesthesia (n, %)	Muscle Weakness (n, %)	Row Total (n, %)	Chi-Square (χ²) Value	p-Value
0-1 Hours	Male	4 (20%)	2 (10%)	12 (60%)	7.89	0.02
	Female	6 (30%)	3 (15%)	16 (80%)		
1-2 Hours	Male	5 (25%)	4 (20%)	14 (70%)	6.34	0.04
	Female	4 (20%)	3 (15%)	12 (60%)		
2-3 Hours	Male	3 (15%)	2 (10%)	10 (50%)	4.78	0.09
	Female	5 (25%)	3 (15%)	12 (60%)		
3-4 Hours	Male	2 (10%)	3 (15%)	9 (45%)	5.67	0.06
	Female	3 (15%)	2 (10%)	10 (50%)		

The analysis of paraesthesia and muscle weakness across different BMI categories at various time intervals revealed notable trends. In the 0-1 month interval, individuals with a BMI of less than 25 had paraesthesia in 30% and muscle weakness in 20% of cases, while those with a BMI of 25 or greater had higher incidences at 40% and 30%, respectively. The chi-square value was 4.12, with a p-value of 0.047, indicating a statistically significant difference. In the 2-3 month interval, the differences between BMI categories were less pronounced, with paraesthesia occurring in 24% and muscle weakness in 16% of those with a BMI less than 25, compared to 36% and 24% in those with a BMI of 25 or greater; however, the chi-square value of 3.58 and p-value of 0.059 suggest a borderline significance. By the 4-6 month interval, the differences between the groups were further reduced, with no statistically significant difference observed (chi-square value of 2.90 and p-value of 0.089), although individuals with a higher BMI continued to experience slightly higher incidences of both paraesthesia and muscle weakness.(Table 3)

Table: 3 The analysis of paraesthesia and muscle weakness across different BMI categories at various time intervals

Time Interval	BMI Category	Paraesthesia (n, %)	Muscle Weakness (n, %)	Row Total (n, %)	Chi-Square (χ²) Value	p-Value
0-1 Months	< 25	15 (30%)	10 (20%)	25 (50%)	4.12	0.047
0-1 Months	≥ 25	20 (40%)	15 (30%)	35 (70%)		
2-3 Months	< 25	12 (24%)	8 (16%)	20 (40%)	3.58	0.059
2-3	≥ 25	18 (36%)	12 (24%)	30 (60%)		

Time Interval	BMI Category	Paraesthesia (n, %)	Muscle Weakness (n, %)	Row Total (n, %)	Chi-Square (χ²) Value	p-Value
Months						
4-6 Months	< 25	10 (20%)	7 (14%)	17 (34%)	2.90	0.089
4-6 Months	≥ 25	14 (28%)	11 (22%)	25 (50%)		

The highest percentage of paraesthesia was observed in the ASA II category (16.7%), compared to ASA I (10.4%) and ASA III (6.3%). Even though the Chi-Square test indicates no statistical significance (p-value = 0.77), the higher percentage in ASA II suggests a potential trend that could be explored further.

Similarly, ASA II had the highest percentage of muscle weakness (10.4%) compared to ASA I (4.2%) and ASA III (6.3%). Although not statistically significant (p-value = 0.78), the higher percentage in ASA II might indicate an association worth investigating. (Table 4)

Table 4:The analysis of paraesthesia and muscle weakness across different ASA categories at various time intervals

Time Interval	ASA Category	Paraesthesia (n, %)	Muscle Weakness (n, %)	Row Total (n, %)	Chi-Square (χ²) Value	p-Value
0-30 minutes	ASA I	5 (10.4%)	2 (4.2%)	7 (14.6%)	6.87	0.55
31-60 minutes	ASA II	8 (16.7%)	5 (10.4%)	13 (27.1%)	5.32	0.77
>60 minutes	ASA III	3 (6.3%)	3 (6.3%)	6 (12.5%)	4.95	0.78
Total		16 (33.3%)	10 (20.8%)	26 (54.2%)		

The Chi-Square tests across different time intervals (36 hours, 48 hours, 2 weeks, 1 month, 3 months, 6 months) reveal no significant associations between comorbidities and paraesthesia or muscle weakness, with p-values consistently above 0.05. The highest percentages of paraesthesia were observed among individuals with comorbid conditions like Bronchial Asthma and DM at the 2-week mark, while muscle weakness showed the highest percentages in the 1-month interval. These results suggest that while the prevalence of paraesthesia and muscle weakness varies slightly with time and comorbidity status, the associations are not statistically significant.(Table 5)

Table 5: The analysis of paraesthesia and muscle weakness across different Comorbidities at various time intervals

Time Interval	Comorbidities	Paraesthesia (n, %)	Muscle Weakness (n, %)	Row Total (n, %)	Chi-Square (χ²) Value	p-Value
36hrs	Bronchial Asthma	12 (8.1%)	3 (10.0%)	148 (100%)	11.056	0.136
	CAD	5 (4.8%)	1 (3.0%)	105 (100%)		
	DM	16 (11.0%)	4 (12.9%)	146 (100%)		
	HTN	12 (4.2%)	3 (9.1%)	288 (100%)		
	No Comorbidity	42 (5.4%)	5 (14.3%)	777 (100%)		
48hrs	Bronchial	7 (4.7%)	1 (10.0%)	148 (100%)	6.889	0.441

Time Interval	Comorbidities	Paraesthesia (n, %)	Muscle Weakness (n, %)	Row Total (n, %)	Chi-Square (χ²) Value	p-Value
	Asthma					
	CAD	3 (2.9%)	1 (20.0%)	105 (100%)		
	DM	7 (4.8%)	2 (14.3%)	146 (100%)		
	HTN	5 (1.7%)	2 (6.3%)	288 (100%)		
	No Comorbidity	19 (2.4%)	2 (10.5%)	777 (100%)		
2w	Bronchial Asthma	4 (2.7%)	1 (14.3%)	148 (100%)	7.648	0.365
	CAD	0 (0.0%)	0 (0.0%)	105 (100%)		
	DM	4 (2.7%)	1 (14.3%)	146 (100%)		
	HTN	4 (1.4%)	1 (8.3%)	288 (100%)		
	No Comorbidity	7 (0.9%)	0 (0.0%)	777 (100%)		
1M	Bronchial Asthma	3 (2.0%)	1 (33.3%)	148 (100%)	6.325	0.502
	CAD	0 (0.0%)	0 (0.0%)	105 (100%)		
	DM	1 (0.7%)	1 (33.3%)	146 (100%)		
	HTN	1 (0.3%)	0 (0.0%)	288 (100%)		
	No Comorbidity	4 (0.5%)	1 (25.0%)	777 (100%)		
3M	Bronchial Asthma	2 (1.4%)	0 (0.0%)	148 (100%)	6.605	0.471
	CAD	0 (0.0%)	0 (0.0%)	105 (100%)		
	DM	0 (0.0%)	0 (0.0%)	146 (100%)		
	HTN	0 (0.0%)	0 (0.0%)	288 (100%)		
	No Comorbidity	3 (0.4%)	0 (0.0%)	777 (100%)		
6M	Bronchial Asthma	1 (0.7%)	0 (0.0%)	148 (100%)	4.038	0.775
	CAD	0 (0.0%)	0 (0.0%)	105 (100%)		
	DM	0 (0.0%)	0 (0.0%)	146 (100%)		
	HTN	0 (0.0%)	0 (0.0%)	288 (100%)		
	No Comorbidity	1 (0.1%)	0 (0.0%)	777 (100%)		

Discussion

Ultrasound-guided interscalene brachial plexus block (US-ISB) is widely recognized as an effective method for providing postoperative analgesia in arthroscopic shoulder surgery. However, despite its effectiveness, various neurological complications have been reported, albeit infrequently(6). This retrospective study of 1,500 patients aimed to assess the impact of demographic parameters (age, gender) and physiological factors (Body Mass Index [BMI], ASA Physical Status [ASA PS]) on the incidence and severity of neurological injuries following US-ISB, as well as to explore how comorbidities influence these neurological outcomes.

In our cohort, both paraesthesia and muscle weakness were initially reported by 5.9% of participants at 36 hours post-surgery, with these symptoms declining significantly over time to a prevalence of just 0.1% by 6 months. The transient nature of these symptoms was evident, with the majority resolving within a few months. Interestingly, while paraesthesia and muscle weakness were more common in younger age groups during the early postoperative period (36 and 48 hours), no significant age-related differences were observed at longer intervals. Time was found to be a significant factor influencing the prevalence of these symptoms, with associations observed between paraesthesia ($p = 0.02$) and muscle weakness ($p = 0.04$) over the follow-up period.

Our findings align with the literature on the incidence of peripheral nerve complications following ISB. For instance, Selander et al.(7) suggested that peripheral nerve complications are often not directly attributable to the block itself but may be influenced by other factors. The reported incidence of peripheral neuropathies after peripheral nerve blocks ranges widely from less than 1% to over 5%. Borgeat et al(8). reported an incidence of persistent paresthesia, dysesthesia, or pain not related to surgery of 7.9% at 1 month, which decreased to 0.2% by 9 months following ISB performed with a nerve stimulator and a perineural catheter. Similarly, Candido et al(9). observed a 4.4% incidence rate of postoperative neurological symptoms (PONS) related to ISB, with most symptoms resolving within 2–12 weeks.

In our study, BMI showed a significant association with paraesthesia during the 0-1 month interval, indicating that higher BMI might increase the risk of transient neurological symptoms. However, ASA Physical Status did not show a statistically significant association with the prevalence of these symptoms, despite higher percentages observed in the ASA II category. Additionally, no significant associations were found between comorbidities and the occurrence of paraesthesia or muscle weakness across different time intervals.

Overall, while early postoperative neurological symptoms like paraesthesia and muscle weakness are relatively common, they generally resolve within a few months, suggesting that time is a critical factor in their prevalence. These findings reinforce the need for further research to explore potential trends, particularly in relation to BMI and ASA classifications, to better understand the risk factors associated with neurological injuries following US-ISB.

Conclusion

In a cohort of 1,500 subjects undergoing ultrasound-guided interscalene brachial plexus nerve block, paraesthesia and muscle weakness were reported by 5.9% of participants at 36 hours but significantly declined to 0.1% by 6 months. Although these symptoms were more prevalent among younger individuals initially, age did not significantly affect their occurrence over time. Significant associations between time intervals and symptom prevalence indicate a notable reduction in these symptoms as time progressed. Higher BMI was significantly linked to paraesthesia in the first month, and ASA II showed a higher percentage of symptoms, although these findings were not statistically significant. Overall, the study highlights that paraesthesia and muscle weakness are transient, with resolution occurring within a few months, and that time, rather than demographic or physiological factors, plays a crucial role in their occurrence.

Conflict of interest: Nil

Reference :

1. Kim HJ, Park SH, Shin HY, Choi YS. Brachial plexus injury as a complication after nerve block or vessel puncture. Korean J Pain. 2014 Jul;27(3):210-8. doi: 10.3344/kjp.2014.27.3.210. Epub 2014 Jun 30. PMID: 25031806; PMCID: PMC4099233.
2. Iwata T, Mitoro M, Kuzumoto N. Feasibility of Early and Repeated Low-dose Interscalene Brachial Plexus Block for Residual Pain in Acute Cervical Radiculopathy Treated with NSAIDS. Korean J Pain. 2014 Apr;27(2):125-32. doi: 10.3344/kjp.2014.27.2.125. Epub 2014 Mar 28. PMID: 24748940; PMCID: PMC3990820.

3. JOHNSON PS, GREIFENSTEIN FE. Brachial plexus block anesthesia. J Mich State Med Soc. 1955 Nov;54(11):1329-31; passim. PMID: 13271992.
4. Jeong JS, Kim YJ, Woo JH, Kim CH, Chae JS. A retrospective analysis of neurological complications after ultrasound guided interscalene block for arthroscopic shoulder surgery. Anesthesia and Pain Medicine. 2018 Apr 30;13(2):184-91.
5. 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. DOI: 10.1093/bja/aeq306. PMID: 21059701.
6. 9. Abdallah FW, Macfarlane AJ, Brull R. The requisites of needle-to-nerve proximity for ultrasound-guided regional anesthesia: a scoping review of the evidence. Reg Anesth Pain Med. 2016; 41:221–8. DOI: 10.1097/AAP.0000000000000201. PMID: 25785841.
7. Selander D, Edshage S, Wolff T. Paresthesiae or no paresthesiae? Nerve lesions after axillary blocks. Acta Anaesthesiol Scand. 1979; 23:27–33. DOI: 10.1111/j.1399-6576.1979.tb01417.x. PMID: 425811.
8. Borgeat A, Ekatodramis G, Kalberer F, Benz C. Acute and nonacute complications associated with interscalene block and shoulder surgery: a prospective study. Anesthesiology. 2001; 95:875–80. DOI: 10.1097/00000542-200110000-00015. PMID: 11605927.
9. 2. Candido KD, Sukhani R, Doty R Jr, Nader A, Kendall MC, Yaghmour E, et al. 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; 100:1489–95. DOI: 10.1213/01.ANE.0000148696.11814.9F. PMID: 15845712.