CASE REPORT

Inadvertent Brachial Plexus Injury after Ultrasound-guided Interscalene Nerve Block: Diagnosis and Recovery

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Abstract

Background: Brachial plexus injury subsequent to an interscalene block (ISB) can be a difficult situation. Ultrasound-guided interscalene block (US-ISB) is currently the preferred technique; however, there is conflicting evidence in the existing literature about the elimination of this uncommon complication. Less is known about the nature and severity of the resulting neurological sequel as only few case studies are available in literature.

Case description: A 28-year-old male underwent an elective removal of the dynamic compression plate and screws in a united fracture of humerus for constant pain with day-to-day activities. An ISB was performed under ultrasound guidance without any remarkable events during the procedure. Untowardly, the patient had experienced complete motor and sensory inactivity around shoulder and elbow in the postoperative period that persisted even at 3 weeks. Magnetic resonance imaging showed evidences of brachial plexus injury involving C5 and C6 roots extending to trunks. A conservative approach with rehabilitation and electrical muscle stimulation (EMS) was followed. Gradual recovery was observed and by 7 months he attained power to preinjury level.

Conclusion: The practice of ISBs for upper limb surgeries does exhibit a rare risk of severe neuronal injury, even with established safe practices using ultrasound guidance. There are inconsistent evidences in the literature regarding permanent damage to brachial plexus following US-ISB and the resulting plexopathy shows complete recovery with conservative management.

Clinical significance: Ultrasound guidance for ISBs may not be totally immune to neurological injury; however, the magnitude is of lesser severity and spontaneous recovery should be the rule.

Keywords: Brachial plexus neuropathy, Function recovery, Interscalene nerve block, Ultrasound interventional.

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Background

A brachial plexus injury subsequent to a routinely performed ISB for upper limb surgeries can be devastating. Larger studies and registry data record an incidence between <0.1 and 19.1/1,000, however, there is lack of uniformity in case representation and criteria considered.[1–3] Although, the use of US-ISB has limited the occurrences, there is conflicting evidence in existing literature pertaining to the elimination of risk and severity of neurological injury as with other techniques.[3,4] Very few case studies are currently available to ascertain the nature and recovery of the brachial plexus injury following an US-ISB.[5] We report this uncommon complication on a patient where despite following the recommended safety variables for US-ISB, the risk was unforeseen.

Case

A 28-year-old male had constant pain in the left arm that exaggerated with exercise and moderate to heavy work for about a year. He had previously sustained a polytrauma event 2 years ago where multiple fractures of both upper limb involving bilateral humerus and right radius and ulna had been surgically stabilized by internal fixation using stainless steel dynamic compression plates and cortical screws under general anesthesia and ISB for analgesia in a staged manner. All the fractures had united in about 6–8 months from stabilization with full gain in range of movements and power across all joints. He underwent surgical removal of implants from the right upper limb under ISB with uneventful postoperative period and relief of pain in follow-up. He presented for an elective removal of implants on the left side. A senior anesthetist with routine practice in brachial plexus blocks performed an ISB with ultrasound guidance (linear Probe, DC-70 Exp; Mindray, China). The nerves C5-C6-C7 were clearly identified. A 23 gauge spinal needle was passed from posterior to anterior direction and in the plane of probe. One milliliter of the reconstituted analgesic solution was infiltrated as test. Despite the needle tip visualized in extra neural position, patient complained of shooting pain that resolved after withdrawal of needle by 2 mm and 24 mL of reconstitute analgesic solution (15 mL of bupivacaine 0.5%, 15 mL of 2% lignocaine with adrenaline, 5 mL of distilled water, and 3 mL of soda bicarbonate) was infiltrated without any pain. Onset of analgesia was observed by 20 minutes and through the previously executed posterior approach to humerus, the plate and screws were successfully removed without any nerve damage.

In the postoperative period, the patient had persistence of inability to move the left shoulder and elbow with decreased sensation over

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shoulder, arm and lateral side of forearm beyond 48 hours after the procedure, however, he had no weakness in the hand and wrist movements. A clinical suspicion of brachial plexus injury involving the upper brachial roots was made. Ultrasound of the neck ruled out any hematoma around the brachial plexus injection site and normal diaphragmatic movements were also visualized. The immediate phase of brachial plexopathy was managed expectantly with oral nonsteroidal anti-inflammatory drugs (NSAIDS), passive joint elbow movements, and scapula stabilizing exercises.

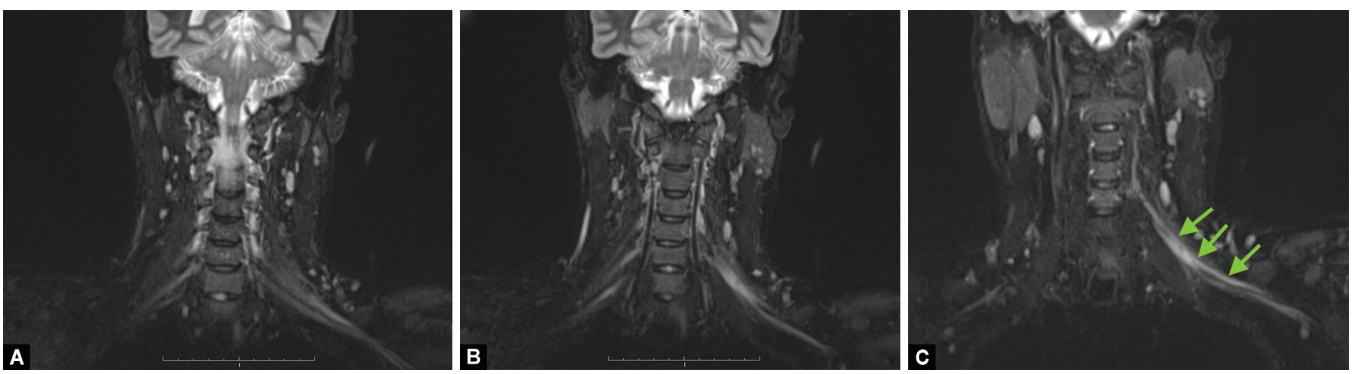
There was no improvement in motor function even at 3rd week; however, the patient gained improvement in sensory perception. Significant deltoid and periscapular muscle wasting were observed. MRI of the brachial plexus showed features of brachial plexus injury involving C5 and C6 roots (Figs 1A to C). Electrical muscle stimulation using low frequency (5–15 Hz) galvanic current over deltoid and biceps was added in the rehabilitation (Figs 2A and B). At 7 weeks follow-up, the patient had minimal improvements in elbow flexion, forearm supination [medical research council (MRC) grade II/V], and shoulder movements (MRC grade I/V). Electrical muscle stimulation was carried out on alternate days with the shoulder joint held at varying degrees of abduction 30, 60, and 90°. The patient gained motor power in shoulder and elbow in the subsequent weeks and in 7 months follow-up, he had full range of active movements in shoulder and elbow, symmetrical scapula coordination but with minimal side-to-side difference in strength (Figs 2C and D). Strength training was advised further.

Discussion

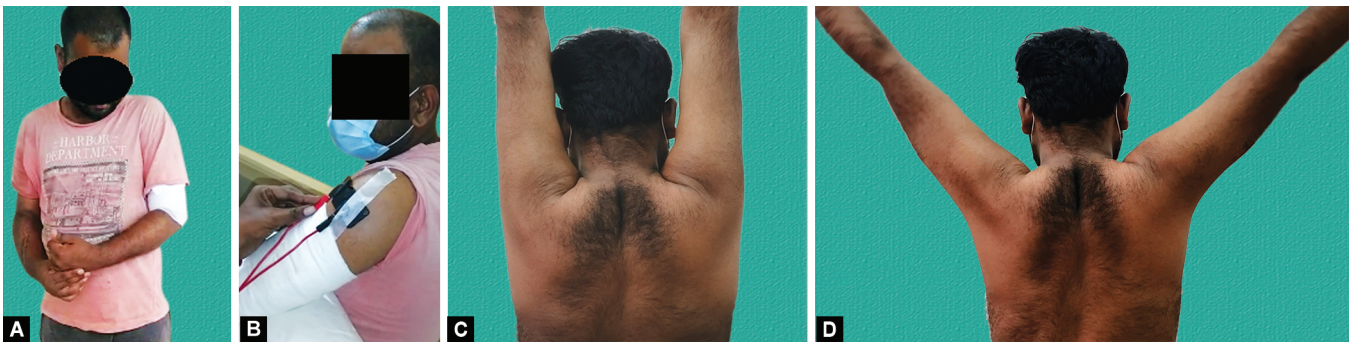
Interscalene block alone or along with general anesthesia is the most common practice of analgesia for upper limb surgeries.[6] Although the procedure can be performed by the traditional or blind method or by nerve localization using nerve stimulator, performing the block using ultrasound guidance has gained popularity because of real time visualization of nerves, avoiding uncomfortable radiculopathy during procedure, decreased requirement of analgesics, and least block failure rates.[2,4,7] The use of ultrasound guidance has also decreased the complications of vascular injection, pneumothorax, phrenic nerve involvement, and hematoma formation.[1,8] Although a rare complication, the concerns about neurological injury cannot be eliminated as with other methods.[3] Holbrook and Parker in their systematic review analyzing the postoperative neurological symptoms (PONS) related to the single site brachial plexus block, observed an overall incidence of 3.6% among 8,543 patients (32 studies between 1945 and 2017 in English literature).[4] The PONS that lasted for about 3 months was 1.7% among the ultrasound guide block as against 4.9% in the nerve stimulator group.

Various proposed mechanisms of nerve injury include chemical toxicity, hematoma or pseudoaneurysm formation, direct trauma by needle placement, size of needle, and pressure of infiltration (>15 psi) have been observed and studied widely.[2,5,9] The method of paresthesia/shooting pain elicitation to localize and infiltrate analgesics suggests intrafascicular needle placement and has been linked to brachial plexopathy.[10,11] Our patient developed plexopathy despite any evidence of intraneural, intrafascicular injection (no swelling of the nerve on ultrasound). Liu et al. retrospectively reviewed the ultrasound images of the procedure in 286 patients, and observed intraneural placement of needle in 17% of patients. Among them, 22 patients had received intraneural infiltration of anesthetic and 21 patients received analgesic infiltration after correcting the needle tip position.[12] However, none of them developed any neurological injury in both the groups. Some anatomic studies have demonstrated unintentional intraneural placement of needle by up to 50%. Such higher incidences have occurred due to the difficulty in maintaining a sustainable alignment of the probe and needle tip while infiltration because of poor echogenicity and argued that intraneural placement may cause prolonged blockade and delayed recovery in case of intrafascicular needle tip trauma (pain on infiltration) but did not amount to neurological injury.[13]

There exists lack of uniformity in the clinical presentation, duration of symptoms, and the investigations modality considered in the published studies to define the criteria for a neuropathy that resulted from a brachial plexus block.[2] Neurodiagnostic tests and magnetic resonance imaging (MRI) of brachial plexus have been of additive value in diagnosis and to ascertain the nature of injury.[14,15] However, studies have documented PONS with normal nerve conduction and electromyography and *vice versa*. Similarly, MRI scans have also been normal in various instances. One arguable factor about the existing inconsistencies with neurodiagnostic tests and MRI were that minor symptoms like paresthesia were considered and that with neuropathy were considered not related to procedure.[2] Oliver-Fornies et al. in their study of 5,340 patients who underwent ultrasound-guided brachial plexus blocks for various upper limb surgeries from a single center observed about 15 patients with PONS (new onset of sensory motor symptoms of a particular nerve that lasted for more than 10 days), however, only three patients had features of injury that were directly related to the block procedure, three had undetermined etiology, and rest of them were due to original trauma or surgery related.[16] Again, in



Figs 1A to C: (A and B) 3D T2 SPACE STIR MR neurography images of left-sided brachial plexus taken at 1 month post the ISB. Coronal images show hyperintense signals of the left postganglionic C5, C6 roots and upper trunk level; (C) hyperintense signals are also noted extending along the upper divisions (green arrows)



Figs 2A to D: Clinical images of left-sided brachial plexus injury and recovery. (A) Patient had no power across elbow and shoulder requiring opposite limb assistance for movement at 3rd week follow-up; (B) EMS and rehabilitation; (C and D) Full recovery in power of muscles around the shoulder and elbow at 7 months follow-up

this study not all cases had demonstrated changes in neurodiagnostic studies. Our patient underwent an ISB that lead to a complete sensory and motor weakness in distribution of the C5 and C6 roots, which was reflective in both neurodiagnostic test and MRI at 3 weeks.

Unlike brachial plexus injury resulting after nerve stimulator method of ISB, the injury subsequent to US-ISB present with sensory and limited weakness of C5 and C6 root distribution that recovers spontaneously within weeks.[2,6,14,15] However, a complete paralysis for more than 3 months have been rarely reported with longest recovery by 12 months.[5,13] Shio et al. reported a case of grade III injury (Seddon's classification) of the C5-C6-C7 nerve roots in a soccer player following an ultrasound-guided catheter placed for continuous analgesia after arthroscopic shoulder surgery.[5] A definite cause was uncertain, but a dose-depended neurotoxicity with continuous infiltration was believed. The patient recovered completely to preinjury levels at 8 months from the procedure. All the established safe practices for a single site US-ISB were followed; we could not identify any particular reason for the neurological injury. The MRI of brachial plexus showed a similar pattern of injury as with previous case report. With EMS and supervised rehabilitation our patient recovered completely at 7 months follow-up.

Conclusion

The ISBs for upper limb surgeries does exhibit a remote risk of neuronal injury even with established safe practices using ultrasound guidance. The resulting plexopathy, however, shows complete recovery with conservative management.

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References

1. Jeong JS, Kim YJ, Woo J, et al. A retrospective analysis of neurological complications after ultrasound-guided interscalene block for arthroscopic shoulder surgery. Anesth Pain Med 2018;13(2):184–191. DOI: 10.17085/apm.2018.13.2.184
2. Barrington MJ, Watts SA, Gledhill SR, et al. Preliminary results of the Australasian Regional Anesthesia Collaboration: a prospective audit of more than 7000 peripheral nerve and plexus blocks for neurologic and other complications. Reg Anesth Pain Med 2009;34(6):534–541. DOI: 10.1097/aap.0b013e3181ae72e8
3. Sharma BS, Chung C. Incidence and risk factors for neurological injury after interscalene peripheral nerve block at an academic institution. J Clin Anesth 2020;61:109654. DOI: 10.1016/j.jclinane.2019.109654
4. Holbrook HS, Parker BR. Peripheral nerve injury following interscalene blocks: a systematic review to guide orthopedic surgeons. Orthopedics 2018;41(5):e598–e606. DOI: 10.3928/01477447-20180815-04
5. Shio H, Sakura S, Motooka A, et al. Severe and persistent nerve palsy after ultrasound-guided continuous interscalene brachial plexus block in a teenager undergoing shoulder surgery: a case report. JA Clin Rep 2020;6(1):15. DOI: 10.1186/s40981-020-0315-1
6. 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 2022;6(1):149–154. DOI: 10.1016/j.jseint.2021.08.008
7. Singh A, Kelly C, O'Brien T, et al. Ultrasound-guided interscalene block anesthesia for shoulder arthroscopy: a prospective study of 1319 patients. J Bone Joint Surg Am 2012;94(22):2040–2046. DOI: 10.2106/JBJS.K.01418
8. Orebaugh SL, Williams BA, Vallejo M, et al. Adverse outcomes associated with stimulator-based peripheral nerve blocks with versus without ultrasound visualization. Reg Anesth Pain Med 2009;34(3):251–255. DOI: 10.1097/AAP.0b013e3181a3438e
9. Neal JM, Bernards CM, Hadzic A, et al. ASRA practice advisory on neurologic complications in regional anesthesia and pain medicine. Reg Anesth Pain Med 2008;33(5):404–415. DOI: 10.1016/j.rapm.2008.07.527
10. Avellanet M, Sala-Blanch X, Rodrigo L, et al. Permanent upper trunk plexopathy after interscalene brachial plexus block. J Clin Monit Comput 2016;30(1):51–54. DOI: 10.1007/s10877-015-9681-z
11. Cohen JM, Gray AT. Functional deficits after intraneural injection during interscalene block. Reg Anesth Pain Med 2010;35(4):397–399. DOI: 10.1097/aap.0b013e3181e8a35f
12. Liu SS, YaDeau JT, Shaw PM, et al. Incidence of unintentional intraneural injection and postoperative neurological complications with ultrasound-guided interscalene and supraclavicular nerve blocks. Anesthesia 2011;66(3):168–174. DOI: 10.1111/j.1365-2044.2011.06619.x
13. Bigeleisen PE. Nerve puncture and apparent intraneural injection during ultrasound-guided axillary block does not invariably result in neurologic injury. Anesthesiology 2006;105(4):779–783. DOI: 10.1097/00000542-200610000-00024
14. Antonakakis JG, Ting PH, Sites B. Ultrasound-guided regional anesthesia for peripheral nerve blocks: an evidence-based outcome review. Anesthesiol Clin 2011;29(2):179–179. DOI: 10.1016/j.anclin.2011.04.008
15. Fredrickson MJ, Kilfoyle DH. Neurological complication analysis of 1000 ultrasound-guided peripheral nerve blocks for elective orthopaedic surgery: a prospective study. Anesthesia 2009;64(8):836–844. DOI: 10.1111/j.1365-2044.2009.05938.x
16. Oliver-Fornies P, Ortega Lahuerta JP, Gomez Gomez R, et al. Postoperative neurological complications after brachial plexus block: a retrospective study conducted at a teaching hospital. J Anesth 2021;35(6):844–853. DOI: 10.1007/s00540-021-02989-7