Am J Transl Res 2026;18(1):470-474
www.ajtr.org /ISSN:1943-8141/AJTR0159849

Case Report

Rare neurological complications subsequent to brachial plexus block: a case report and literature review

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Received August 15, 2024; Accepted December 9, 2025; Epub January 15, 2026; Published January 30, 2026

Abstract: Brachial plexus block anesthesia is widely utilized for upper limb surgical procedures in clinical settings. The diffusion of local anesthetics within the intermuscular sulcus structure can lead to nerve paralysis. However, we report an exceptionally rare case of concurrent extensive neural blockade, with a spread far beyond expected boundaries, which carries significant clinical cautionary implications. This case report described a previously healthy patient who successfully underwent arthroscopic rotator cuff repair on the right shoulder under general anesthesia combined with a brachial plexus block. Following an ultrasound-guided intermuscular groove approach for brachial plexus block and superficial cervical plexus block, the patient developed numbness and reduced muscle strength in the right upper and lower limbs, along with unresponsiveness to painful stimuli. This paralysis lasted for at least 48 hours. Postoperative cranial computerized tomography (CT) and cervical X-ray showed no significant abnormalities. No neurological sequelae were observed after the complete resolution of the anesthetic effect. Necessary but limited tests and examinations were performed to establish a differential diagnosis, effectively excluding cerebral infarction, spinal disorders, peripheral vascular and nerve diseases, electrolyte abnormalities, and hysteria. While it is hypothesized that local anesthetics may contribute to lower limb paralysis, the specific mechanism by which these agents affect the nerves in this region remains unclear and requires further investigation.

Keywords: Complete unilateral limb paralysis, interscalene brachial plexus block, case report

Introduction

Brachial plexus block anesthesia is widely utilized in clinical practice for upper limb surgery due to its notable advantages [1]. The established intermuscular groove approach delivers consistent and reliable anesthetic outcomes, thereby facilitating smooth surgical procedures. Additionally, ultrasound-guided technology significantly enhances the accuracy and safety of nerve blocks, thereby reducing the incidence of complications [2, 3].

However, despite its widespread use, brachial plexus block anesthesia still carries potential risks. Drug diffusion may result in unintended adjacent nerve blocks, such as phrenic nerve palsy and Horner syndrome - rare complications that nonetheless warrant clinical attention [4]. From an anatomical perspective, lower extremity nerve blocks are seldom observed under routine conditions, primarily due to the distinct location and structure characteristics of the relevant nerves [1].

This article presents an exceptional case, examining its clinical features, diagnostic process, and outcomes. Unlike the transient and localized complications commonly seen in the literature, the patient in this case presented with concurrent extensive neural blockade, manifesting as numbness and reduced muscle strength in both the right upper and lower limbs. This atypical presentation, with paralysis extending well beyond the expected anatomical boundaries of a brachial plexus block, poses significant diagnostic challenges and clinical management dilemmas. The aim of this article is to offer valuable insights and reference for clinical practitioners and contribute to future research in this field.

https://doi.org/10.62347/TMNU3861

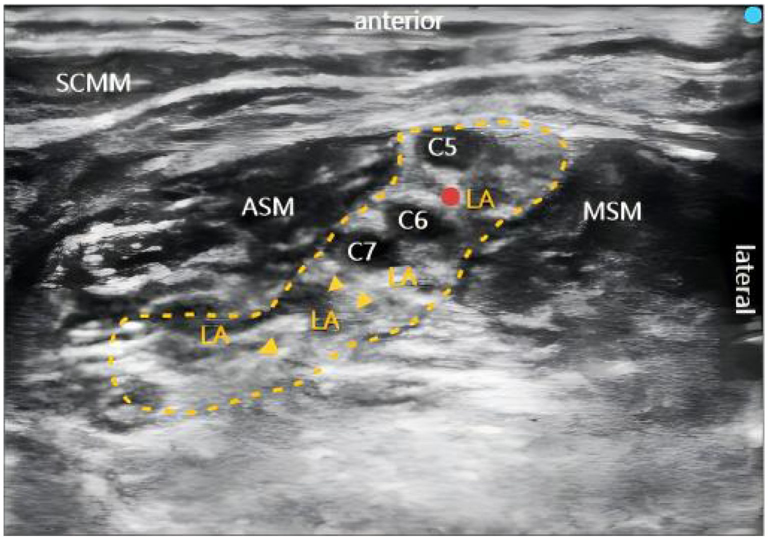

Figure 1. Ultrasound image following intermuscular groove brachial plexus blockade. The puncture needle is inserted from the lateral to the medial aspect. The red dot marks the site of drug injection, while the yellow dotted line delineates the suspected distribution area of the local anesthetic. The anesthetic may propagate along the direction of the arrow toward deeper layers and potentially reach the subdural space. SCMM: sternocleidomastoid muscle, ASM: anterior scalene muscle, MSM: middle scalene muscle, LA: local anesthetic. The yellow dotted line illustrates the potential dispersion of local anesthetics.

Case report

An adult, approximately 170 cm in height and weighing about 60 kg, with a well-proportioned physique, was admitted to the hospital due to chronic right shoulder pain accompanied by restricted range of motion that had persisted for over ten years. Preoperative evaluation revealed no significant medical comorbidities, and the patient had no history of hypertension, diabetes, or cardiovascular disease. The patient successfully underwent arthroscopic examination and right rotator cuff repair under general anesthesia supplemented with a brachial plexus block.

In the operating room, an ultrasound-guided intermuscular groove approach brachial plexus block was performed using 20 ml of 0.375% ropivacaine hydrochloride (AstraZeneca AB) (**Figure 1**). A superficial cervical plexus block was simultaneously administered using 10 ml of the same anesthetic solution. Under ultrasonic guidance, the local anesthetic was injected around the anterior scalene muscle using a nerve puncture needle (B. Braun Melsungen AG, Stimuplex D, 0.71 × 50 mm, 22 G, 15° bevel). Following the procedure, the patient reported a burning sensation in their ipsilateral lower limb. Within 15 minutes, numbness developed in both the upper and lower limbs on the right side, resulting in motor impairment and loss of response to painful stimuli. No signs of respiratory compromise were observed, and all vital signs remained stable throughout the procedure.

Subsequently, the patient was induced under general anesthesia using 120 mg of propofol (2 mg/kg) and 6 μg of sufentanil (0.1 μg/kg). After confirming complete loss of consciousness, a size 4.0 LMA® Supreme™ laryngeal mask was inserted, and anesthesia was maintained with 2% sevoflurane, with the concentration adjusted according to clinical requirements. No muscle relaxants were administered during the entire procedure. The patient remained hemodynamically stable during the operation, and extubation was uneventful postoperatively before he was safely transferred to the ward.

After surgery, the patient exhibited persistent bilateral upper and lower extremity paresthesia predominantly on the right side, accompanied by decreased muscular strength and sensory deficits in the right cervical region. However, the patient's vital signs remained stable, and postoperative cranial computerized tomography (CT) and cervical X-ray examinations revealed no abnormalities. Due to the short illness duration and the patient's refusal, key diagnostic tests like electromyography and magnetic resonance imaging (MRI) were not carried out. During the 72-hour follow-up period, anesthesia began to subside 12 hours postoperatively, progressing from the lower limbs and to the upper limbs. Muscle strength gradually returned to baseline levels. By 48 hours post-surgery, the effects of anesthesia on the limbs had largely resolved; however, cervical numbness persisted for a total of 68 hours.

No therapeutic interventions beyond necessary specialist treatments or prophylactic anticoagulation were administered. No sequelae were observed after the complete resolution of anesthetic effects.

Discussion

The intermuscular groove approach for brachial plexus block involves the injection of local anesthetic between the anterior and middle scalene muscles in the neck, where the brachial plexus is situated [1]. This anatomical arrangement facilitates the diffusion of the drug into the surrounding tissues. However, despite advances in ultrasound technology, this approach cannot completely prevent unintended spread, as ultrasound imaging is limited to two-dimensional visualization and cannot accurately depict longitudinal drug distribution. Consequently, adjacent structures such as the phrenic nerve or cervical sympathetic ganglion may be inadvertently affected [4-6].

The unintentional spread of local anesthetics to the cervical epidural space, resulting in bilateral analgesia and contralateral limb neurological symptoms, has been documented in multiple case reports [7, 8]. Stunder et al. employed magnetic resonance imaging to evaluate the tissue distribution of ropivacaine at volumes of 5 ml and 20 ml following an interscalene brachial plexus block, specifically assessing involvement of the phrenic nerve and epidural space [6]. Their results demonstrated that, among 15 patients, 2 (13.3%) exhibited epidural spread, with larger volumes associated with more extensive dispersion into the intervertebral foramen and phrenic nerve. In cadaveric studies, contrast agent injections administered beneath the prevertebral layer of the deep cervical fascia resulted in epidural spread in 4 out of 5 cases, as shown on CT scans [9].

The spinal nerve dura is a continuous extension of the dura mater. Direct needle penetration of the spinal nerve dura or excessive pressure during injection may allow local anesthetics to enter the epidural space along the nerve root within the vascular nerve sheath, thereby inducing an epidural block. In this instance, excessive contralateral head rotation during the nerve block may have stretched the nerve root outward, increasing the degree of extradural protrusion. If an accidental epidural block or total spinal anesthesia occurs, it typically presents with bilateral numbness. However, in this case, the patient was positioned in the left lateral decubitus position during surgery. If an epidural block occurred, gravitational effects might have caused the anesthetic to spread to the contralateral side, which contradicts our observation of numbness limited to the right limb. Although unilateral limb blockade resulting from local anesthetics reaching the thoracolumbar segments via the epidural space has not been previously documented, this hypothesis remains plausible. Potential anatomical pathways, such as the dura-arachnoid ligaments, may serve as conduits for the targeted delivery of local anesthetics to the nerves innervating the lower limbs [10]. Further investigation is warranted to validate these observations.

The dose administered in this study (20 mL of 0.375% ropivacaine, total dose 75 mg) falls within the conventionally recommended range for this type of surgical block [11]. However, as previously noted, a higher volume of local anesthetic is associated with an increased risk of unintended spread [6, 9]. Both the volume and concentration of local anesthetics are critical determinants of their distribution. Therefore, the relatively large volume used in this instance may have contributed significantly to the extensive diffusion of the drug into the epidural space.

From an anatomical perspective, the likelihood of brachial plexus block resulting in lower limb paralysis is extremely low [1]. Other, more plausible causes of lower limb paralysis include cerebral infarction, a major and commonly observed serious complication during the perioperative period. Cerebral infarction arises from insufficient cerebral blood supply, leading to ischemic brain tissue damage. Clinical manifestations may vary, ranging from headache, nausea, vomiting, and dizziness to numbness or weakness in one limb, as well as slurred speech [12]. Based on the patient's clinical presentation and imaging findings, cerebral infarction was effectively excluded, a critical determination for guiding treatment decisions and predicting prognosis.

Preoperative imaging and postoperative evaluations effectively ruled out cervical spondylosis and lumbar disc herniation as potential causes of lower limb paralysis, based on the patient's medical history, clinical manifestations, and comprehensive diagnostic findings [13].

Local vascular disorders or neuropathies affecting the lower extremities, which may result in lower limb paralysis, usually have well-defined etiological mechanisms that evolve over time. For example, chronic vascular disease in the lower limbs can lead to impaired blood circulation [14]. Electrolyte abnormalities that potentially cause lower limb paralysis typically manifest with generalized symptoms rather than isolated unilateral limb weakness. Hypokalemia, for instance, reduces muscle excitability and often presents with systemic features.

Although the probability of hysteria is low, it cannot be completely ruled out. Hysteria during an operation, a psychological disorder characterized by emotional outbursts, loss of self-control, and physical symptoms such as spasms, typically occurs under conditions of extreme psychological stress and tension [15]. Such episodes may indicate underlying cognitive dysfunction. However, no comprehensive psychological assessment was performed. Given the patients' consistent emotional stZability, cooperative behavior, and normal cognitive performance throughout the treatment process, hysteria was deemed unlikely and subsequently excluded.

Although this study conducted a comprehensive analysis of the case and excluded various potential pathogenic factors, there are still certain limitations. First, this study is a single-case retrospective analysis, and the limited sample size restricts the generalizability of the research conclusions. Second, intraoperative real-time monitoring of neuroelectrophysiological indicators, such as electromyography or nerve conduction velocity, was not performed, which may lead to the omission of objective evidence of transient nerve injury. Third, the diffusion path of local anesthetics within the nerve sheath was not tracked using imaging techniques, such as enhanced MRI to observe the distribution pattern of the drug. Fourth, there was a lack of in-depth analysis of the patient's past diseases, such as the presence of subclinical vascular lesions before the operation. Fifth, nerve biopsy or pathological examination was not conducted, so rare pathogenic factors such as idiopathic neuritis could not be completely ruled out. Future studies should combine intraoperative nerve monitoring techniques, advanced imaging, and pathological verification to more accurately reveal the pathogenesis of such complications.

In summary, considering the current medical history, available theoretical knowledge, and technical resources, it remains challenging to reach a definitive etiological diagnosis for this patient. We present this case report in the hope that readers who encounter similar cases or hold alternative viewpoints may contribute their insights and engage in further discussion.

Acknowledgements

This study was financially supported by the Agricultural and Social Development Project in Yinzhou District, Ningbo City, Zhejiang Province (2024AS036, and 2024AS063), and Ningbo Clinical Research Center for Orthopedics, Sports Medicine & Rehabilitation (2024L004).

Informed consent was obtained from all individual participants included in the study.

Disclosure of conflict of interest

None.

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