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Diaphragmatic Paralysis After Interscalene Nerve Block: Just Saline or a Saviour! A Hamlet Situation.

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KEYWORDS

Interscalene block, normal saline, diaphragm, phrenic nerve

ABSTRACT:

Introduction: The Interscalene nerve block has been performed as a primary technique for upper humerus surgeries for quite some time. The hemidiaphragmatic paralysis that accompanies the block can be distressing, placing the anaesthesiologist in a problematic situation. The minimum reported incidence of hemidiaphragmatic paralysis following this block is 20%, even with ultrasound-guided, very low volume and concentration of the drug. This has led to several modifications of the original technique and drug in terms of dosage, volume, and concentration. However, the incidence remains significant and is large enough to be overlooked. A method that can reverse hemidiaphragmatic paralysis while preserving the desired block effects can prove to be a valuable asset to the anesthesiologist. Here, we report a case of successful reversal of hemidiaphragmatic paralysis caused by phrenic nerve involvement resulting from an interscalene block. Normal saline was injected in the same area where the interscalene block was performed in the patient scheduled for midshaft humerus fracture

1. Introduction

Peripheral nerve blocks have been attracting anaesthesiologists, especially with the advent of ultrasound. This advancement has revolutionized patient comfort through the simplicity of the technique, improved perioperative analgesia, a low complication rate, and the ability to avoid general anaesthesia. The persistent issue of quadriceps weakness in the lower limb that accompanies the block for postoperative analgesia has led to the development of various adaptations of the established technique, namely the femoral nerve block [1]. The traditional interscalene block remains unmatched by any other nerve block in terms of its remarkable effects on intraoperative and postoperative analgesia for invasive shoulder surgeries. The resulting hemidiaphragmatic paralysis often

accompanies the C5-C6 root block, with a reported incidence of 20% or less. It has prompted several modifications to the original technique and drug, concerning dosage, volume, and concentration; yet, the incidence remains significant enough to warrant attention [2,3].

The following is a description of a life-saving “saline washout” technique in the event of inadvertent phrenic nerve paralysis due to an interscalene nerve block in a patient undergoing upper limb surgery.

CASE REPORT

A 51-year-old female with a right midshaft humerus fracture was scheduled for plating. The patient was a known case of asthma and obstructive sleep apnea, using intermittent home BiPAP therapy and requiring a Fluticasone inhaler on an as-needed basis. She had a past surgical history of laparoscopic cholecystectomy, during which she experienced a delayed recovery from anesthesia and was admitted to the Intensive Care Unit for one day. The plan was to operate under regional anesthesia to avoid unnecessary airway manipulation. Preoperative investigations, including a chest X-ray and ECG, were routine. The general examination was routine, with no dyspnea at rest. The preoperative heart rate was 80 beats per minute, blood pressure was 120/70 mm Hg, and SpO2 was 100% on room air. The patient was taken to the preoperative holding area, which was fully equipped with resuscitation equipment. Under all aseptic precautions and ultrasonographic guidance, a right interscalene brachial plexus block was performed using a 23G Quinke’s needle from the lateral to medial direction, and eight cc of 0.5% bupivacaine was administered. A right subclavian perivascular block was performed using 15 cc of 0.5% bupivacaine. After 10 minutes, adequate sensory and motor blockage was achieved, and the patient was shifted to the operating theatre. However, the patient became visibly restless, and SpO2 dropped from 94% to 100%. In the patient's words, he was fighting for every breath. Oxygen supplementation was initiated with a Hudson’s mask at 6L/min. SpO2 improved to 96%, but the patient remained dyspneic. As the ECG was normal and the patient was hemodynamically stable, a cardiac cause of dyspnoea was ruled out. Administration of the drug under ultrasonographic vision and hemodynamic stability practically ruled out local anesthetic systemic toxicity. Pneumothorax was ruled out by looking for lung sliding on ultrasonography. Ultrasonographic diaphragmatic assessment was performed bilaterally in the subcostal region, revealing a significant reduction in diaphragm amplitude on the ipsilateral side of the block. The thickness of the diaphragm was measured in the anterior axillary line, which also showed a decrease compared to the contralateral side. A provisional diagnosis of ipsilateral phrenic nerve paresis was made. Arterial blood gas analysis showed a pO2 of 60 mm Hg and a pCO2 of 55 mm Hg. We proceeded with the “washing off technique” to reverse phrenic nerve paresis. In a propped-up position, a 20cc bolus of normal saline was administered in the interscalene groove under ultrasonographic guidance. Symptomatic improvement was noted as early as 3 minutes after the saline injection, with SpO2 rising to 98% on 2l/min oxygen flow via nasal cannula. The motor and sensory block was preserved. Reassessment of the diaphragm confirmed improvement in amplitude and thickness (Table). Surgery was completed uneventfully without additional analgesics.

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Table- ULTRASONOGRAPHIC MEASUREMENTS OF THE DIAPHRAGM

	INSPIRATORY THICKNESS	EXPIRATORY THICKNESS	AMPLITUDE
PRESALINE AND POST BLOCK	.11	.07	1.02
POSTSALINE 5 MIN	.15	.10	1.53
10MIN	.22	.14	1.61
1.5 HOUR	0.23cm	0.14cm	1.63cms

DISCUSSION

We were faced with a crisis like Hamlet, i.e., to go with the flow or take a risk, to intubate or to put another block with normal saline. In the above case report, the patient received an interscalene block and developed dyspnoea due to phrenic nerve paralysis. Our sixth sense suggested another interscalene infiltration, utilizing an already well-established standard saline washout technique.

The reversal of phrenic nerve palsy by interscalene nerve block was first described by Tsui in 2012.4. They inserted a catheter at C6-C7, but the drug inadvertently reached the anterior scalene, causing paralysis and dyspnoea. Case reports indicate that saline use in the epidural space reduces blockage.5 Normal saline lavage for incorrect subarachnoid injections mitigates adverse effects[4,5]. This inspired the use of saline in the interscalene space to reverse phrenic nerve blocks, enhancing the safety of interscalene blocks and ultrasound-guided regional anesthesia. Tsui noted in a 2013 article that the interscalene continuous catheter dose should be restricted to 2 mL/hour, as the original 5-6 ml/hour can cause adhesions, permanent diaphragmatic damage, and myotoxicity[6,7].

The proximity of the phrenic nerve (approximately 0.18 cm) to the injection point for the interscalene block poses a challenge, despite improvements in technique, volume, and drug concentration (Figures 1, 2). The minimum reported incidence of hemidiaphragmatic paralysis following this block is 20%, even with ultrasound-guided low volume and concentration of the drug[1,8]. A history of obstructive sleep apnoea supports using regional anaesthesia, as general anaesthesia would be more problematic.

Single injection reversal of respiratory distress after interscalene block has been previously described by Tsui, Fleming, Ngai, Robert et al[4,8-10].

The washing-off technique did not lead to any motor or sensory reversal of the block, as the patient remained comfortable and pain-free during surgery. The hemidiaphragmatic paralysis reversal, without motor or sensory block reversal, can be attributed to variations in nerve impulse traffic and fiber size. The phrenic nerve, with its small fibers and high impulse traffic, is quickly blocked and easily reversed by normal saline, unlike the brachial plexus, which has low impulse traffic. This shows effective analgesia and motor effect despite improved diaphragmatic movement and paralysis reversal. Previous literature supports using 20cc of normal saline to reverse hemidiaphragmatic paralysis[8]. The mechanism involves local pH change, reduced intraneuronal concentration due to the dilution of local anesthetic, and sodium ion alteration concentration.

We faced a difficult situation: securing the patient's airway and proceeding with ventilation, a priority for the anaesthesiologist, or using a technique not sufficiently supported by trials. The prior issue of delayed recovery from general anaesthesia led us to choose the latter. Medical literature often demonstrates a 'parachute approach' and reliance on anecdotal evidence instead of evidence-based medicine[4]. The phrenic nerve block phenomenon can't be included in a randomised control trial, but a similar approach is welcome. In a randomised control trial, Lynn injected 10 ml increments of Normal saline within 1 hour of the block, preventing the progression of diaphragmatic paralysis and preserving the analgesic effect of the local anaesthetic on the brachial plexus[9].

Drawing from our experience of significantly enhanced patient symptoms, SpO2 levels, and measurable diaphragmatic (USG) parameters, we suggest that the saline washout technique for unintentional diaphragmatic paralysis after an interscalene block has great potential and could be life-saving.

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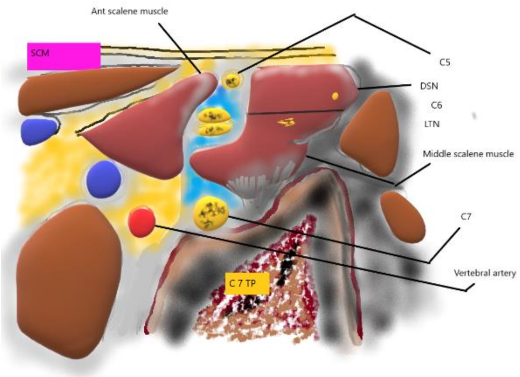

Figure 1-Interscalene block; Reverse Ultrasound Anatomy at the level of C7 transverse process

SCM, sternocleidomastoid; ASM, anterior scalene muscle; LCa, longus capitis muscle; VA, vertebral artery; MSM, middle scalene muscle; LTN, long thoracic nerve; DSN, dorsal scapular nerve; C7-TP, transverse process of C7.

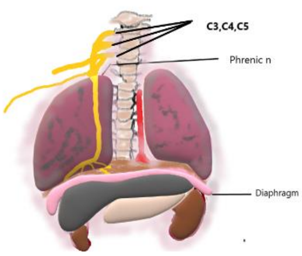

Figure 2-Innervation of the diaphragm by the phrenic nerve (arising from C3, C4, C5 cervical spinal nerve roots)