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CASE REPORTS

# Permanent hemidiaphragmatic paresis after interscalene brachial plexus block: a case report

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**Abstract** Interscalene brachial plexus block has been widely used in shoulder surgery. We report one case of long-term phrenic palsy following ultrasound-guided interscalene brachial plexus block and we will discuss the possible etiology and mechanism of this disability. For painful shoulder surgery, ultrasound-guided interscalene brachial plexus block remains topical. Alternative blocks, such as suprascapular and axillary blocks, may be reserved for patients with pre-existing respiratory pathology.


## Introduction

Interscalene Brachial Plexus Block (IBPB) has been widely used in shoulder surgery allowing better intraoperative and postoperative pain management and a reduction in hospital stay.[1]

Although it is usually considered a safe block, the risk of complications like hemidiaphragmatic paresis as a result of ipsilateral phrenic nerve block has been reported.[2–4]

This type of paresis is often transient and is resolved over the duration of the local anesthetic's action, but it results in a decrease in forced vital capacity of 20–25%.[2,3] Although ultrasound allows better visualization of structures, recent literature suggests that the incidence of this potential severe complication is higher than previously indicated.[2–4]

We report one case of long-term phrenic palsy following IBPB after ultrasound guidance and we discuss the possible etiology and mechanism of this disability.

## Report

A 64-year-old male (72 kg, 170 cm) was scheduled for an exeresis of sebaceous cyst of the left shoulder. Vital signs (blood pressure, temperature, and oxygen saturation) were normal.

His medical history included hypertension, hypercholesterolemia, left hypertrophic cardiomyopathy with normal ventricular function, and a sleep apnea syndrome requiring temporary apparatus between 2002 and 2007 before weight

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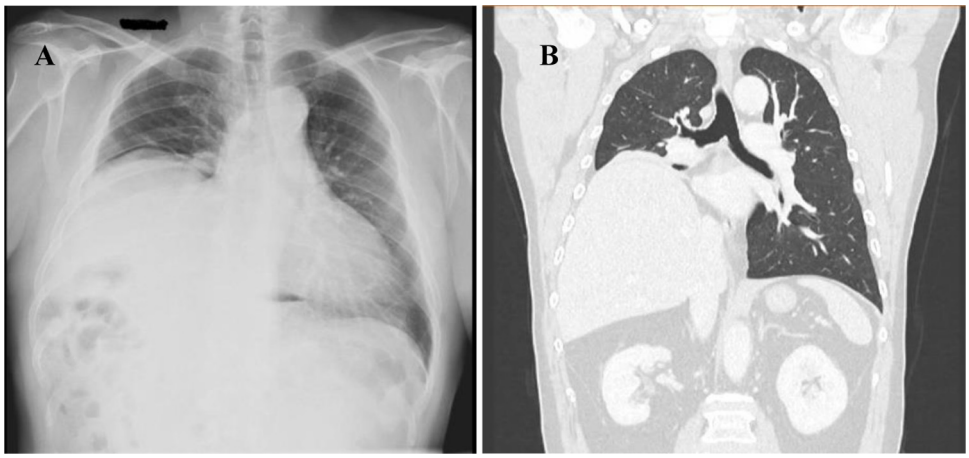


**Figure 1** Chest X-ray (A) and thoracoabdominal computed tomography (B) with an important rise in the right diaphragmatic dome evoking a diaphragmatic paresis.

loss and epigastralgia. He never had general anesthesia and had one surgery of hemorrhoids with spinal anesthesia. His routine drug therapy consisted of lercanidipine 10 mg once daily, fenofibrate 160 mg once daily, and esomeprazole 20 mg. No additional paraclinical examination was requested. We decided to allow the surgery with only an IBPB.

After the intravenous route was secured in the contralateral forearm, routine monitors (ECG, noninvasive blood pressure, pulse oximetry) were applied. The skin was prepared in typical sterile fashion. The IBPB was performed using a S-Nerve ultrasound system (SonoSite®, Bothell, WA, USA) with a 13–6 MHz 38-mm high-frequency linear array transducer (HFL38×; SonoSite®). The transducer was covered with a sterile adhesive bandage (Microtek®, Ecolab®, Zutphen, The Netherlands).

IBPB was performed with a 4 cm 24G needle (SonoTap®, Pajunk®, GA, USA) in the posteriocaudal medial direction, under ultrasound visualization without nerve stimulation. Fifteen millilitres of mepivacaine 1.5% was injected lateral from the plexus at the level of C6 and perineural spread around all nerve roots with local anesthetic was confirmed with ultrasound. After 20 minutes, a sensory blockade was observed without adverse effects.

The surgery time took totally 30 minutes and it was done without any problem. The patient remained in the postanesthesia care unit for 20 minutes. The patient returned to ambulatory care and he was discharged from the hospital 6 hours after the end of the surgery without problem.

Twenty-four hours after discharged he reported a short breath and dyspnea. Given the asymptomatic character of the exertional dyspnea, multiple blood exams and a coronary angiography were performed. They were normal. However, the chest X-ray demonstrated phrenic nerve paralysis, with a very important rise in the right diaphragmatic dome evoking a diaphragmatic paresis (Figure 1A). Respiratory functional exploration found a severe restrictive syndrome with a vital capacity at 1.86 L that is 46% of normal vital, a Tiffeneau coefficient at 75%, and a total lung capacity of 3.9 L that is 59% of normal. Ambient air saturation at rest was 96%, at the walking test of 6 minutes there was no desaturation and the distance travelled was 450 meters, or 67% of the theoretical distance.

Thoracoabdominal computed tomography confirms that the right diaphragmatic dome is raised with atelectasis of the pulmonary parenchyma related to the dome lift without any specific appearance anomaly (Figure 1B).

Cervical-thoracic Magnetic Resonance Imaging (MRI) found no root compression nor right phrenic nerve nor right brachial plexus abnormality.

Unfortunately, one year after the surgery the respiratory functional exploration was discreetly improved, and he has to benefit from nocturnal ventilatory support.

## Discussion

The incidence of transient diaphragm paresis following a successful IBPB is almost 100% but a permanent diaphragm paralysis is rare, with an incidence of 0.048% to 0.1%.[2,3] For our institution, it is our first case described.

The mechanism for prolonged hemidiaphragmatic paresis is unclear. Some factors that may lead to prolonged diaphragmatic paresis include infections, metabolic problems, alcoholism, vitamin deficiencies, exposure to toxins, and trauma or pressure on the nerve.[2,3]

In our patient medical history, there were no vitamin deficiencies, alcoholism, metabolic problems, or the existence of a preexisting subclinical polyneuropathy. Other potential causes could be evoked, like nerve damage due to direct needle trauma, intraneural injection, or an inflammatory scarring that could be responsible for a nerve entrapment.[2,3] Regarding the risks of surgical trauma, the installation had been properly verified, patient was awake, and there is a low risk for direct surgical trauma.

Causes described for inflict nerve injury, as transection, piercing, stretching, and compression (by needle or anesthetic product) seem unlikely, especially since we used the sonographic method. In this case, we used a technique of lateral to medial puncture because we know it is best to avoid damage to the phrenic nerve. Indeed, a puncture lateral to medial presents risk of damage to the long thoracic and dorsal scapular nerve while a puncture medial to lateral

presents an increased risk for vascular and phrenic nerve lesions.[2,3] However, the sonographic technique does not prevent paralysis because prolonged phrenic nerve palsy has been reported after ultrasound guided IBPB.[2–5] The combination of the ultrasound and nerve stimulation technique may seem interesting to detect if the needle was close to the nerve. In our case no nerve damage or compression was found in cervical-thoracic MRI.

The volume administered may be responsible for high incidences of diaphragmatic paresis. A volume of 5 to 10 mL can prevent the risk of paresis and toxicity associated with local anesthetic.[3–5] Nevertheless, a recent study shows that low volumes can lead to diaphragmatic paresis in one third of cases in obese patients.[4,5] In addition, risk factors for neuropathy are identified such as diabetes, cervical brachial pathology, history of surgery or cervical trauma, or obesity.[3–5] Our patient had none of these risk factors, but the volume injected was probably too important (15 mL).

A high risk of toxicity for neural structures after interscalene brachial plexus block has been demonstrated in prospective studies that identified brachial plexus damage (i.e., sensory dysfunction a week or more after interscalene brachial plexus block that is not attributable to other causes) in 4.4–14% of block subjects.[6–8] Permanent sensory dysfunction is much more rare because of neuronal regrowth and the plentiful redundancy and plasticity of peripheral and central sensory systems.[6–8]

Recovery is thought to be quite good and often takes 6 to 12 months with the normalization of vital capacity.[9] In a retrospective study in 23 consecutive patients with uni- or bilateral diaphragm paralysis, Gayan-Ramirez et al. (2008) demonstrated that functional recovery occurred in 43% of the patients after 12 months and in 52% after 24 months.[10] Type and etiology of paralysis did not influence recovery. Compound motor action potential of the diaphragm, anthropometric characteristics, and baseline pulmonary function did not predict functional respiratory recovery. Moreover, it did not result in a greater percentage functional respiratory recovery.[10] Relapse after an initial improvement was observed in 26% of the patients.[10] Most patients with asymptomatic unilateral diaphragmatic paralysis do not require treatment. Surgical options are considered if the underlying cause is treated and the patient still has symptoms, or if the patient has bilateral diaphragmatic paralysis.[10,11] There are various treatment options including plication and phrenic nerve stimulation. Plication of the affected site is a very useful treatment method that allows weaning from mechanical ventilation.[10,11] Plication is preferably performed in unilateral diaphragmatic paralysis in non-morbidly obese patients.[10,11] Phrenic nerve stimulation is performed in intact phrenic nerve without evidence of myopathy. This procedure can be performed in patients with bilateral diaphragmatic paralysis with cervical spine injuries.[10,11]

After one year, our patient unfortunately did not regain normal function and was dyspneic at efforts. He only feels an improvement in his adaptation to effort after starting kinesitherapy. Surgical diaphragmatic plication will be proposed if the symptoms persist.

As this case shows, and despite its importance in painful shoulder surgery, IBPB can have rare but serious long-lasting side effects, especially in respiratory function.[1,3–5] Although the IBPB has advantages over general anesthesia (particularly with volatile agents), which includes better perioperative analgesia, decreased incidence of postoperative nausea and vomiting, and faster postanesthesia care unit discharge times in ambulatory surgery, its indication can be discussed according to the surgery.[1,12]

In conclusion, the benefits of IBPB with regard to postoperative analgesia should be weighed against the risks of potential devastating complications.[1–3] The combined low-volume, ultrasound guided and alternative blocks, such as suprascapular and axillary blocks, may reduce rate of hemidiaphragmatic paresis while providing good analgesia when compared with IBPB.

## Conflicts of interest

The authors declare no conflicts of interest.

## References


1. Beecroft CL, Coventry DM. Anaesthesia for shoulder surgery. CEACCP. 2008;8:193–8.
2. El-Boghdadly K, Chin KJ, Chan VWS. Phrenic nerve palsy and regional anesthesia for shoulder surgery: anatomical, physiologic, and clinical considerations. Anesthesiology. 2017;27:173–91.
3. Buise MP, Bouwman RA, van der Gaag A, et al. Phrenic nerve palsy following interscalene brachial plexus block; a long-lasting serious complication. Acta Anaesthesiol Belg. 2015;66:91–4.
4. Riazi S, Carmichael N, Awad I, et al. 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;101:549–56.
5. Marty P, Ferre F, Basset B, et al. Diaphragmatic paralysis in obese patients in arthroscopic shoulder surgery: consequences and causes. J Anesth. 2018;32:333–40.
6. 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.
7. Borgeat A, Dullenkopf A, Ekatodramis G, Nagy L. Evaluation of the lateral modified approach for continuous interscalene block after shoulder surgery. Anesthesiology. 2003;99:436–42.
8. Candido KD, Sukhani R, Doty R Jr, 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. Anesth Analg. 2005;100:1489–95.
9. Xu WD, Gu YD, Lu JB, et al. Pulmonary function after complete unilateral phrenic nerve transection. J Neurosurg. 2005;103:464–7.
10. Gayan-Ramirez G, Gosselin N, Troosters T, Bruyninckx F, Gosselink R, Decramer M. Functional recovery of diaphragm paralysis: a long-term follow-up study. Respir Med. 2008;102:690–8.
11. Ricoy J, Rodríguez-Núñez N, Álvarez-Dobaño JM, et al. Diaphragmatic dysfunction. Pulmonology. 2019;25:223–35.
12. Gonano C, Kettner SC, Ernstbrunner M, et al. Comparison of economic aspects of Interscalene Brachial plexus blockade and general anaesthesia for arthroscopic shoulder surgery. Br J Anaesth. 2009;103:428–33.