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Incidence of vocal cord paresis following ultrasound-guided interscalene nerve block: An observational cohort study☆

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Background: Interscalene brachial plexus block (IBPB) has become a standard practice for perioperative analgesia for shoulder procedures. However, several side effects may occur owing to its anatomic location. We have chosen to evaluate vocal cord paresis and dysphonia following interscalene blocks.
Methods: After IRB approval, eight patients undergoing arthroscopic shoulder procedures were recruited into this prospective

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cohort study. Following informed consent, vocal cords were assessed by standardized fiberoptic evaluation. Subsequently, IBPB was performed under ultrasound (US) guidance. Patients were re-evaluated for vocal cord changes by a repeat fiberoptic assessment one hour following IBPB. Our primary outcome measure was incidence of vocal cord immobility.

Results: No patients had diminished vocal cord motion, dysphonia, or dysphagia.

Conclusions: Although larger studies are required to determine the true incidence of vocal cord paresis following US-guided IBPB, our results suggest that incidence of unwanted nerve blockade other than brachial plexus is much lower than that previously described.

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Introduction

Many techniques have been developed to minimize perioperative pain for patients undergoing shoulder surgery, including interscalene brachial plexus block (IBPB), supraclavicular nerve block, opioid-based general anesthesia, and intra-articular analgesic injection with a variety of volumes and concentrations of medications that have been used. First described by Winnie et al., in 1970, IBPB is based on the concept of the brachial plexus being enveloped by a fascial sheath that isolates the plexus to a single functional anatomical compartment [11,12]. Given this understanding of the plexus, successful IBPB can be accomplished by a single injection of an adequate volume and concentration of local anesthetic into the compartment.

Since the conception of IBPB, development of more specific techniques in regional anesthesia, including ultrasound (US) guidance and neurostimulation, have allowed anesthesiologists to minimize the anesthetic volume required to achieve a successful block, thus reducing iatrogenic nerve paresis caused by undesired local anesthetic spread to nearby neurovascular structures [13–15]. However, owing to the proximity of the cervical plexus, sympathetic afferents, and recurrent laryngeal nerve, several side effects may occur, including diaphragmatic paresis [1–3], Horner's syndrome [4–6], and dysphonia.

Yet, there is a paucity of generalizable studies describing the true incidence and extent of undesired nerve paresis specifically associated with IBPB. In 1991, Urmey et al. demonstrated a 100% incidence of ipsilateral hemidiaphragmatic paresis in a 13-patient series [2]. However, they used 34–52 mL of 1.5% mepivacaine with added epinephrine and bicarbonate. These are much larger volumes of local anesthetic than those that are utilized by anesthesiologists presently. In fact, there is evidence to support that a low-volume technique with as low as 5 cc volumes for single-shot interscalene blocks can provide comparative postoperative analgesia as that when 20 cc of local anesthetic is used [10]. Another prospective study comparing US-guided supraclavicular and interscalene blocks demonstrated a 31% incidence of dysphonia in the postanesthesia care unit in 515 patients undergoing IBPB [9]. However, in this study, the measurement of dysphonia was subjective, and its incidence may have been confounded by endotracheal intubation or nerve injury during surgery [7–9].

In the present study, the authors seek to objectively demonstrate the incidence of recurrent laryngeal nerve paresis directly attributable to IBPB by evaluating vocal cord function immediately before and 1 h after introduction of the anesthetic, without intervening endotracheal intubation, thus avoiding this potentially confounding variable. We have chosen the volume of 20 cc 0.5% bupivacaine based on the institution standards at the time of the study and for the expectation of both surgical analgesia efficacy and postoperative pain relief. We surmise through this study that vocal cord changes are minimal or not clinically significant with 20 cc of 0.5% bupivacaine that would provide a clinical difference in vocal cord function and phonation.

Methods

Eight patients undergoing ambulatory arthroscopic shoulder procedures requiring IBPB at Montefiore Medical Center (Bronx, New York) were recruited into this novel prospective cohort study. Patients with past medical history of respiratory disease, pneumonectomy, head and neck disease (radiation, cancer, or previous surgeries), and/or previously known vocal cord disease were excluded from the study. After obtaining informed consent, each enrolled patient received a standard pre-anesthetic evaluation. Then, each patient had their vocal cords assessed by an otolaryngologist using a fiberoptic laryngoscope with video-recording capabilities using a standard ENT assessment, as verified by our ENT colleagues. Vocal cord structure and function were evaluated at this time, with particular focus on dysphonia and fold hypokinesis. This was done before any airway manipulation or surgery to represent a pure comparison of functionality at baseline to that following a nerve block with standard local anesthetic, nerve block technique, and timing of the assessments. Subsequently, IBPB was performed by an anesthesiologist using 20 mL of 0.5% bupivacaine under US guidance and nerve stimulator confirmation, which was the standard analgesic volume and concentration used at our institution at the time of this study for this patient population. After confirming a successful block, by verbal confirmation from the patient as well as physical examination consistent with motor and sensory changes in the interscalene distribution, we waited exactly 1 h to re-evaluate the vocal cords. Repeat evaluation was performed by the same otolaryngologist using a fiberoptic flexible laryngoscope at the bedside. All otolaryngologic evaluations were video recorded and independently reviewed by a second otolaryngologist with an expertise in the larynx. Intraoperatively, all patients received general anesthesia with endotracheal intubation per surgeon preference. Patients were also followed up by the regional anesthesia and acute pain service team after surgery.

Approval for this study was obtained from the Institutional Review Board (IRB) of Montefiore Medical Center. Baseline characteristics including age, gender, body mass index, past medical history, and ASA score were recorded for each enrolled patient. Our primary outcome measure was the objective incidence of vocal cord paresis, as confirmed by a specialist, 1 h after IBPB.

Results

Eight patients were enrolled in the study, of which 6 (75%) were female. Mean age was 56.5 ± 19.8 years, while mean BMI was 27.9 kg/m^2 ± 4.6. Median ASA score was 2, with a range from 1 to 3. The most common comorbidity was hypertension (62.5%). One patient had a prior transient ischemic attack with no residual laryngeal dysfunction or documented sensory or motor weakness. Upon otolaryngological evaluation both before and one hour after IBPB, no patients had dysphagia, dysphonia, or diminished vocal cord motion. No patients experienced dysphonia postoperatively after extubation.

Discussion

The brachial plexus comprises the anterior rami of C5-T1 spinal nerves and is responsible for providing innervation to the ipsilateral upper limb. Proximally through distally, the plexus is divided into components, namely, roots, trunks, divisions, cords, and terminal branches, and can be blocked at either of these sites depending on the location of desired nerve blockade. The interscalene portion of the brachial plexus lies between the anterior and middle scalene muscles, which are contained within the prevertebral fascia. The use of US-guided nerve blocks with concurrent nerve stimulation helps to minimize the volume of anesthetic required to achieve successful blocks. Nevertheless, when entering the fascial sheath of the interscalene brachial plexus, the anatomic proximity of important nerves may result in undesired paresis of the cervical plexus (phrenic nerve), sympathetic afferents, and recurrent laryngeal nerve.

Hemidiaphragmatic paresis resulting from local diffusion of the anesthetic to the cervical plexus has been studied extensively [2,16–18], including investigation of pulmonary function [19–22]. Phrenic nerve palsy has been noted to occur in all (100%) cases, of which 10% are clinically significant, with reductions of up to 25% in forced vital capacity and 15% of peak expiratory flow rate [23]. One study claims that the minimum effective volume of anesthetic (ropivacaine 0.75%) to prevent pulmonary

function changes in US-guided C7 blocks in 95% of patients is 3.6 mL [24]. Despite our understanding of hemidiaphragmatic paresis following IBPB, less is known about the incidence and extent of recurrent laryngeal nerve involvement. Previous studies noted an incidence of dysphonia in the postanesthesia care unit between 15% and 31% [9,10], depending on the volume of anesthetic used. However, these studies used a subjective measurement of dysphonia, which also may have been confounded by airway manipulation or nerve injury during surgery. To the best of the authors' knowledge, this study represents the first objective analysis of vocal cord mobility as a result of potential recurrent laryngeal nerve paresis secondary to IBPB.

Most cases of vocal cord paresis following IBPB presented in literature are temporary, and improvement is seen within 24 h [23,25]. Furthermore, mild unilateral vocal cord paresis may be clinically difficult to determine. Therefore, confirmation by direct visualization using fiberoptic otolaryngological examination is a more precise method in determining the true incidence of vocal cord motion impairment. This examination before any airway manipulation or surgery may control for confounding factors that can also contribute to dysphonia in this setting, such as laryngeal trauma during endotracheal intubation, general anesthesia, oxygen delivery, and surgical stress. In the present study, there was a no (0%) incidence of objective vocal cord paresis as confirmed by otolaryngological examination. Furthermore, no (0%) patients experienced subjective postoperative dysphonia. The limitation of this study is that we have a limited patient sample, as it was difficult to coordinate otolaryngologic evaluations in the context of perioperative flow. Although our patient sample size was limited, these findings are important considerations when discussing the risks and benefits of IBPB with patients preoperatively. Further investigation into the incidence of vocal cord paresis following IBPB with large, controlled studies in the future can help collaborate our observations in this pilot study.

Although we did not observe any vocal cord paresis or dysphonia in this study, the incidence of this complication may increase with the use of larger anesthetic volumes. Unfortunately, given the tasks of scheduling patients to arrive early to a preoperative holding area in a busy joint replacement center and coordinating schedules with otolaryngology who were volunteering their time away from clinical duty to perform these assessments, we limited our study to a small sample size and committed to the analysis of one anesthetic volume and concentration: 20 mL of 0.5% bupivacaine. This volume is sufficient to achieve a therapeutic block in virtually every patient scenario and was the standard medication concentration and volume provided to patients at the time of this study; therefore, our results may be generalizable to the larger population of patients undergoing arthroscopic shoulder procedures. On the other hand, as our study was limited to using one anesthetic, with one volume and concentration, we cannot generalize our findings to other medications or concentrations. This is an important consideration, as different anesthetics have varying pharmacokinetic profiles with different degrees of motor blockade.

The generalizability of this study is strengthened by the fact that patients recruited into this study had very liberal inclusion criteria except for concrete preoperative motor dysfunction. Included patients had multiple comorbid conditions including hypertension, obesity, and diabetes mellitus. However, other important exclusion criteria were previous laryngeal injury or potential damage to the area secondary to radiation or surgical intervention. The assumption here is that having pre-existing laryngeal nerve injury would make laryngoscopic examination more difficult and less valid. In other words, pre-existing damage to the vocal cords or laryngeal nerves could preclude a reliable assessment of the structure and function of the larynx.

This preliminary study establishes the initial hypothesis of the safety of IBPB with regard to vocal cord function, and our results indicate that the true incidence of vocal cord paresis is lower than the 31% reported in literature or is due to other causes. To quantify this lower incidence, larger studies are required. Additionally, it would be important to find the volume threshold for causing recurrent laryngeal nerve involvement, and therefore, designing a study using different volumes of anesthetic would prove valuable. An anatomic consideration that we do not account for in this study is that the course of the recurrent laryngeal nerve is different on either sides of the neck. It is not known whether this affects the rates of iatrogenic dysphonia and vocal cord paresis.

Despite the limitations of this study, this is the first objective investigation into vocal cord function following IBPB. With no (0%) incidence of objective vocal cord paresis and subjective dysphonia, we

conclude that 20 mL of 0.5% bupivacaine causes successful block while preventing recurrent laryngeal nerve paresis. However, future prospective investigation of IBPB with varying anesthetic types and volumes is necessary to further validate the findings in the present study.

Practice points

- IBPB is a safe and reliable technique to provide perioperative anesthesia and analgesia for shoulder procedures.
- Bupivacaine 0.25% (20 mL) injected under ultrasound guidance reliably produces a therapeutic block.
- Vocal cord paresis and dysphonia did not occur in any of our patients post IBPB.
- It may be possible to get recurrent laryngeal nerve involvement if larger local anesthetic volumes are used, and future studies with varying volumes may be helpful for further evaluation.

Research agenda

- Larger studies are needed to validate our preliminary findings regarding safe use of IBPB with no incidence of vocal cord paresis noted.
- We need evidence of a volume threshold of local anesthetic used, if any, that would cause recurrent laryngeal involvement in IBPB.
- We need studies that use different types of local anesthetics to further confirm our findings, as the response may differ by drug pharmacokinetics.

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None.

Conflicts of interest

The authors declare no conflict of interest.

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