Use of a Nerve Stimulator for Phrenic Nerve Block in Treatment of Hiccups

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HICCPUS may be managed with several methods, such as stimulation of the pharynx, compression of the eyeballs, gastric lavage, sedation, and inhalation of carbon dioxide.1,2 If these treatments fail, block of the phrenic nerve has been suggested as the "last resort."1,2 Moore has suggested that if hiccups did not stop after the first attempt at blocking, the procedure should be repeated.3

Fluoroscopy1 or chest radiographs taken during inspiration and expiration (double-exposure method)4 can confirm the paralysis of the diaphragm after phrenic nerve block. However, even when the phrenic nerve is blocked, the diaphragm may not be paralyzed.5,6 Therefore, objective tests that would detect the successful phrenic nerve block are useful. We report the use of a nerve stimulator for confirmation of phrenic nerve block.

Case Reports

Case 1

A 73-yr-old man was referred to our department for treatment of intractable hiccups, which had been occurring intermittently for several years. The frequency of hiccups was 3-4 per min. Several procedures, such as administration of chlorpromazine or diazepam, or stimulation of the pharynx, had been ineffective. Medical history was unremarkable except for mild hypertension. Cranial computed tomography scanning and gastric endoscopy did not detect any abnormality. Fluoroscopy showed that both sides of the diaphragm moved caudally during inspiration, indicating no evidence of paralysis of the diaphragm; hiccups were associated with contractions of both sides of the diaphragm.

The left phrenic nerve was blocked using the method described by Moore.3 The patient was instructed to lie in the supine position and to move the head away from the side where the block was to be performed. The lateral border of the clavicular head of the sternocleidomastoid muscle was located, and a skin wheal made at a level about 2.5 cm above the clavicle. The sternocleidomastoid muscle was then grasped by fingers and pulled away from the neck. A 25-gauge needle was inserted through the skin wheal and advanced underneath the sternocleidomastoid muscle to the space between this muscle and the anterior scalenus muscle. Ten milliliters of 0.5% bupivacaine were injected, although the hiccups did not stop. Several days later, the right phrenic nerve was blocked using the same method, but it was not effective either. The block was repeated several times, but it was generally ineffective.

To confirm that the phrenic nerve was properly blocked by the local anesthetic, we used an electric nerve stimulator. After informed consent was obtained from the patient, a 25-gauge insulated needle (Neutracer with Pole needle, Top Surgical MFG. Co., Ltd, Tokyo, Japan), which was attached to a nerve stimulator (Synchro SD 201, Neuro-Trace, HDC Corporation, Mountain View, CA), was inserted into the space between the sternocleidomastoid and anterior scalenus muscles. Initially, electric stimuli at 1 Hz and 2 mA were applied to the needle. Stimulation of the nerve caused diaphragmatic contractions; the contraction synchronized with the stimulation, and thus it was easy to differentiate the stimulation-induced diaphragmatic contractions from hiccups.

The amplitude of electric stimulation was then gradually decreased while the position of the needle was adjusted to maintain the maximum contraction. Diaphragmatic contractions were obtained as low as an electric current of 0.75 mA. While the electric stimulation was being applied, 0.5% bupivacaine was then slowly injected through the insulated needle. Within 1 min, after infusing 5.0 ml bupivacaine, the motor response disappeared; an additional 5.0 ml bupivacaine was infused. However, despite the total absence of the response to the nerve stimulation, hiccups still persisted.

On the next day, the right phrenic nerve was blocked using the same method. The diaphragm contracted during nerve stimulation as low as 0.75 mA. The motor response disappeared after injection of 8.0 ml 0.5% bupivacaine; 10 ml was injected. Neither did the right phrenic nerve block decrease hiccups.

Therefore, we considered that a successful block of the unilateral phrenic nerve of either side would not decrease hiccups in this patient and abandoned this method.

Case 2

A 68-yr-old man with an advanced cancer of the left lung was suffering from intractable hiccups. Chest radiographs showed that
almost all the left lung was affected by the tumor. The left phrenic nerve was blocked using a nerve stimulator to confirm the location of the nerve and to minimize the volume of a local anesthetic: the diaphragmatic responses were obtained as low as an electric current of 1.0 mA. Five milliliters of 0.5% bupivacaine was injected. Hiccups stopped for several hours after the injection.

Discussion

The phrenic nerve is generally considered as the sole motor nerve supplying to the diaphragm. It originates mainly from the fourth cervical spinal roots, runs obliquely across the front of the anterior scalenus muscle and beneath the sternocleidomastoid muscle, enters the thorax, and terminates in the diaphragm. However, the accessory phrenic nerve may exist in 20–84% of people. It is usually derived from the fifth cervical nerve, runs parallel to the main phrenic nerve, and usually joins the main nerve in the root of the neck or behind the clavicle. Therefore, the diaphragm may not always be paralyzed even if the main phrenic nerves are blocked.

In a previous case report, hiccups persisted even after the bilateral phrenic nerves had been cut surgically. However, hiccups were stopped permanently only after the cut left phrenic nerve was re-exposed, and the nerve was extensively removed (for about 30 cm). Similar results have been reported by another researcher. These results suggest that the accessory nerve was involved in causing hiccups in these cases, and hiccups ceased when the accessory nerve was also removed during extensive stripping of the phrenic nerve.

Several mechanisms have been suggested for generating hiccups. When the origin is at the supraspinal site, both side of the diaphragm may contract during hiccups. In such circumstances, the external intercostal muscles also contract, possibly through nerves other than the phrenic nerve. Therefore, the phrenic nerve block, particularly unilateral phrenic nerve block, may not be effective when hiccups are central in origin.

Bilateral phrenic nerve block could have stopped hiccups in case 1. However, we did not administer this block because repetitive unilateral phrenic nerve blocks (either left or right) had not reduced the severity of symptoms. In addition, bilateral phrenic nerve block reduces the vital capacity and might cause dyspnea or hypoxia. Caution is required even when unilateral phrenic nerve is blocked if the other side of the diaphragm is not functioning. The use of fluoroscopy before the block has been recommended.

The use of nerve stimulator enables the operator to locate the phrenic nerve by causing diaphragmatic contraction. This objective method may be particularly useful in patients in whom the sternocleidomastoid muscle is not easily located. With a fixed frequency (1 Hz) of nerve stimulation, it was easy to differentiate stimulation-induced diaphragmatic contractions from hiccups. However, it could be difficult to differentiate these two, particularly when the frequency of hiccups is high. Application of several different frequencies of nerve stimulation may provide a more reliable confirmation. In addition, it has been reported that only the stimulation of the phrenic nerve was effective in decreasing hiccups.

Fluoroscopy or double-exposure chest radiography can detect the paralysis of the diaphragm after phrenic nerve block. However, these cannot differentiate the failure of the phrenic nerve block from the failure of diaphragmatic paralysis after a successful phrenic nerve block. In contrast, when a nerve stimulator is used, it is possible to confirm a successful phrenic nerve block by observing the disappearance of stimulation-induced diaphragmatic contraction. Therefore, it is possible to differentiate whether the failure to stop hiccups is a result of the failure of phrenic nerve block or caused by the existence of the accessory nerve.

In conclusion, we believe that the use of a nerve stimulator is a useful alternative for confirmation of phrenic nerve block and avoids unnecessary attempts at repeated blocks.

References

General Anesthesia in a Patient with an Enlarged Saber Sheath Trachea


“SABER SHEATH” refers to a trachea that is widened in the anteroposterior diameter and markedly narrowed in the transverse plane. This abnormality may give the appearance of a mediastinal mass on lateral radiograph. Saber sheath tracheas are usually smaller than the normal trachea and are associated with chronic obstructive pulmonary disease. We present the case of a patient with a trachea that conformed to the parameters of a saber sheath but was much larger than a normal trachea. This resulted in our inability to mechanically ventilate this patient because of excessive leakage around the endotracheal cuff.

Case Report

A 54-year-old man, with a 14-year history of ankylosing spondylitis, presented for an arthroplasty of the right hip. His cervical, thoracic, and lumbar spines were fused. We opted for an awake fiberoptic intubation with a size 8.0 Mallinckrodt endotracheal tube. This was performed uneventfully; the mass spectrometer indicated a satisfactory end-tidal CO₂ tracing; and his O₂ saturation remained at 99%, with good air entry bilaterally over the thorax as he was manually ventilated. Anesthesia was then induced with a sleep dose of propofol, and he was paralyzed with vecuronium. 6 mg. Anesthesia was maintained with O₂/nitrous oxide and isoflurane (1%). Within 1 min, it was noted that a large leak was present around the endotracheal tube, which was associated with inadequate ventilation of the patient with the North American Drager 2 set at a tidal volume of 800 ml and a frequency of 10 breaths/min. The cuff had been inflated progressively with up to 10 ml of air, and the end-tidal CO₂ ranged from 50 to 60 mmHg. Suspecting a torn cuff, we decided to change to another size 8.0 endotracheal tube using a Sheridan Tracheal Tube Exchanger (Sheridan Catheter Corp., Argyle, NY). However, the leakage continued after replacement. After removal, the original endotracheal tube was noted to be without defect. Another tube exchange using a size 8.5 endotracheal tube was attempted unsuccessfully. The patient remained easy to manually ventilate with an oropharyngeal airway only. In view of his immobile neck and the uncertainty about the reason for the leakage, we decided to reverse the muscle relaxants and wake him, with the aim of investigating his upper airway.

Computed tomography of the neck done within 1 h revealed an enlarged trachea. The largest anteroposterior diameter of the trachea measured 45 mm, and the transverse diameter in that plane was 19 mm. The transverse diameter was less than one half the anteroposterior diameter, in keeping with the description of a saber sheath trachea. No mediastinal masses were noted (Fig. 1). This patient had had previous radiologic investigations of the chest and cervical spine, but no comments had been made as to the size or shape of the trachea. The preoperative chest radiograph report noted only that the lungs were clear. The posteroanterior chest view of the trachea...