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Original Article

A new method for ultrasound-guided superior laryngeal nerve block

Cing-Hung Lan [a,b], Wei-Chun Cheng [a,b], Yao-Lin Yang [a,b,*]

[a] Department of Anesthesiology, Buddhist Tzu Chi General Hospital, Hualien, Taiwan
[b] School of Medicine, Tzu Chi University, Hualien, Taiwan

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ABSTRACT

Objective: A block of the internal branch of the superior laryngeal nerve (ibSLN) is performed to facilitate awake intubation in patients with a difficult airway. The technique is usually done blindly using landmarks. We delineate a new method using ultrasound guidance while performing a superior laryngeal nerve block.

Materials and Methods: After approval by the ethics committee and with permission from the involved families, six unembalmed fresh human cadavers were used for the study. In each cadaver, bilateral ibSLN blocks were performed using ultrasound guidance. The probe was placed longitudinally over the submandibular area to produce a sagittal view. After identification of the greater horn of the hyoid bone and thyroid cartilage, 2 mL methylene blue dye was injected using an out-of-plane method. Another anatomist dissected the tissue to determine if the nerve was bathed in the dye.

Results: All except one of the 12 ibSLNs were bathed in the dye. Ultrasound-guided nerve block was successful in 11 of 12 ibSLN.

Conclusion: Ultrasound may be an alternative method to identify the greater horn of the hyoid bone and thyroid cartilage as landmarks while performing an ibSLN block.

1. Introduction

The superior laryngeal nerve (SLN) bifurcates into the external and internal branches (ibSLN) near the pharynx. The internal branch dominates sensory sensation above the vocal cord [1,2]. An ibSLN block is frequently performed in patients undergoing awake fiberoptic intubation. Usually, this block is done blindly by recognizing the greater horn of the hyoid bone and the superior horn of the thyroid cartilage as anatomic landmarks. Because the resolution of ultrasound has recently improved dramatically, it is possible to use ultrasound guidance for an ibSLN block. However, there are few reports describing this technique. We designed a pilot study using fresh cadavers to test the feasibility of ultrasound-guided ibSLN block.

2. Materials and methods

The study was approved by the ethics committee with permission from involved families who donated corpses for scientific purposes. We studied six thawed unembalmed fresh human cadavers that were frozen to −30°C within 8 hours after death. The cadavers were kept frozen and thawed at 4°C for 72 hours prior to the experiment. A 13–16 MHz, 38-mm broadband linear array ultrasound probe and Sonosite MicroMaxx ultrasound machine (SonoSite Titan; SonoSite Inc, Bothell, WA, USA) were used for structure identification. All cadavers were placed in the supine position with the neck extended, and bilateral ibSLN block was performed under ultrasound guidance. The probe was placed over the submandibular area with a longitudinal orientation (Fig. 1). We tried to identify the greater horn of the hyoid bone and thyroid cartilage, which were hyperechoic signals on sonography (Fig. 2). The thyrohyoid muscle and thyrohyoid membrane were between these two structures. An out-of-plane method was used to inject 2 mL methylene blue between the greater horn of the hyoid bone and the thyroid cartilage, just above the thyrohyoid membrane (Fig. 3). Another anatomist was asked to dissect the tissue and inspect whether the ibSLN was bathed in methylene blue. If the nerve was bathed in the dye, it was considered a successful blockade.

Conflicts of interest: none.

* Corresponding author. Department of Anesthesiology, Buddhist Tzu Chi General Hospital, 707, Section 3, Chung-Yang Road, Hualien, Taiwan. Tel.: +886 9 53972451; fax: +886 3 8560997.
E-mail address: aorta@mail2000.com.tw (Y.-L. Yang).

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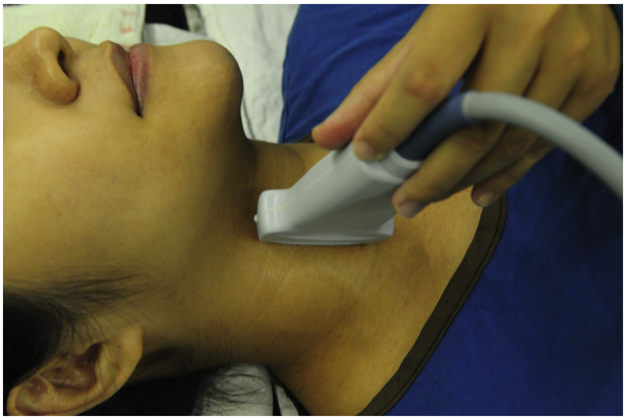

Fig. 1. The probe is placed under the submandibular area in a longitudinal orientation.

3. Results

After dissection of the tissue, we found that all ibSLNs except one were well bathed in methylene blue. Ultrasound-guided nerve block was successful in 11 of 12 ibSLN. The relative anatomy of the ibSLN and the spread area of methylene blue are shown in Fig. 4. The upper folded structure is the greater horn of the hyoid bone and the lower part is the superior horn of the thyroid cartilage. The thyrohyoid ligament is between the two structures. The ibSLN crosses the thyrohyoid ligament advances along the thyrohyoid membrane, and penetrates the innervated mucous sensation above the vocal folds [2]. The nerves were completely covered by methylene blue before they pierced the membrane.

4. Discussion

Awake intubation is sometimes necessary in patients with recognized difficult airways, such as those with head and neck tumors or cervical spine injury. A good topical anesthesia ensures the success of awake intubation. Many methods are used to anesthetize the airway such as spray-as-you-go, lidocaine nebulization, transtracheal spray of lidocaine, and bilateral ibSLN block [3]. The ibSLN block is usually done blindly by recognizing the greater horn of the hyoid bone and the superior horn of the thyroid cartilage as anatomic landmarks [4,5]. However, some reports reveal that

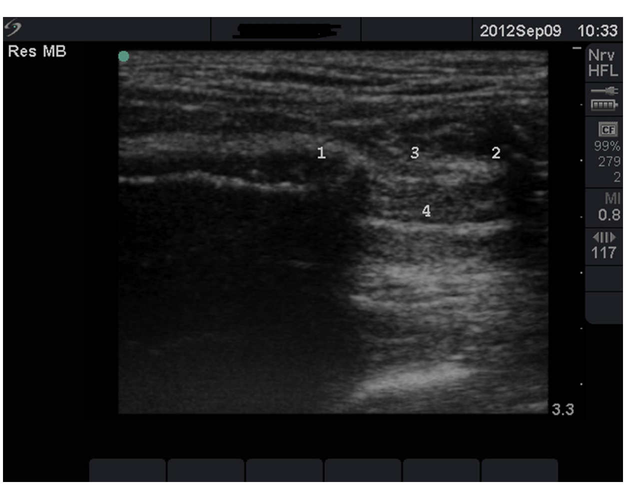

Fig. 2. Preinjection sonography. (1) Superior border of the thyroid cartilage. (2) Greater horn of the hyoid bone. (3) Thyrohyoid muscle. (4) Thyrohyoid membrane.

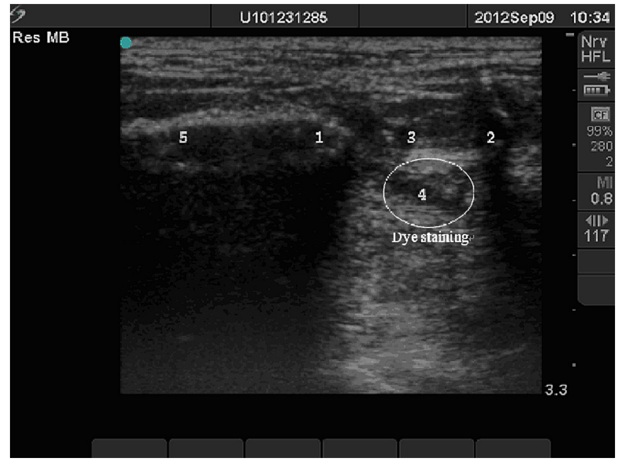

Fig. 3. Postinjection sonography. (1) Superior border of the thyroid cartilage. (2) Greater horn of the hyoid bone. (3) Thyrohyoid muscle. (4) Thyrohyoid membrane. (5) Thyroid cartilage lamina.

ultrasound imaging for nerve blocks is more likely to be successful, takes less time to perform, and has a faster onset, longer duration, and fewer complications (such as intravascular or intraneural injection) than the blind method [6]. The same advantages may be possible with ultrasound-guided ibSLN block. Manikandan et al. described the first case report for which this procedure was used [7]. The authors placed the transducer in the transverse orientation and used an in-plane technique while performing an ibSLN block in a patient with a history of posterior cervical spine fixation. Under ultrasonography, the authors recognized the superior laryngeal artery and ibSLN, which advanced along with the superior laryngeal artery. They injected local anesthetic agents near the superior laryngeal artery after negative aspiration of blood. Awake intubation was performed without complications after ultrasound-guided ibSLN block.

We delineated another method for ibSLN under ultrasound guidance. We placed the probe in a longitudinal orientation and used an out-of-plane technique. After identifying the greater horn of the hyoid bone and the thyroid cartilage as landmarks, we injected dye instead of local anesthetic agents to see the area of the dye spread. The rate of success was high, with 11 of 12 nerves bathed in dye. In the single failed blockade, the nerve was not bathed in the methylene blue and the dye spread into the tissue above the ibSLN. We determined that the depth of the needle insertion was not adequate in this instance. One limitation of this method is that the depth of the needle cannot be precisely determined when using an out-of-plane technique. Another reason for the failure is that the block was done in cadavers. Ultrasonic differentiation of tissue interfaces is not as good as that in live human patients. Sometimes the signal intensity of the thyrohyoid membrane is inadequate. All of these reasons led to the single failed blockade. There is one report revealing that the anatomic location of the ibSLN is not influenced by factors such as sex or ethnicity. Using landmarks as a guide is reliable [4]. In addition, in live patients, the pulse of the superior laryngeal artery could probably be detected using color Doppler and used as a surrogate to locate the position of the superior laryngeal nerve and inject local anesthetic agents [7]. We assume that it will be easier to undertake an ibSLN block in live patients compared with cadavers.

Kaur et al presented transverse oriented ultrasound-guided SLN block [8]. Our report also confirmed that ultrasound-guided SLN block is feasible. However, differences exist between these two studies. Kaur et al placed the probe in the sagittal plane first and

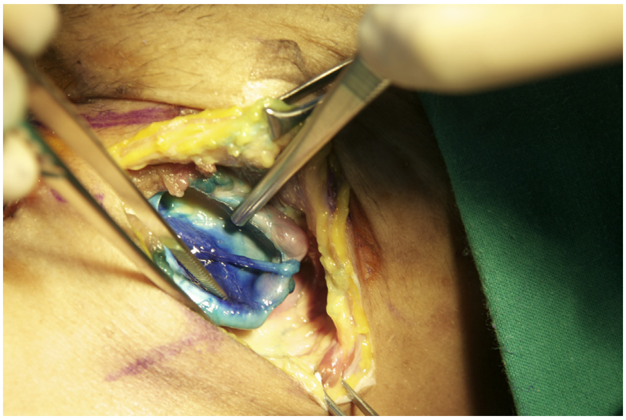

Fig. 4. The upper folder structure is the greater horn of the hyoid. The lower part is the superior horn of the thyroid cartilage. The ibSLN crosses the thyrohyoid ligament and is bathed in methylene blue.

then rotated it to the transverse view to locate the SLN. This technique may not be easy for inexperienced practitioners to perform. We used only the longitudinal view, which can identify all landmarks at once and is easy to perform. Although we did not identify the SLN, the success rate remained high. This proves that even with a low resolution transducer (see limitations in the next paragraph) that cannot identify the SLN, ultrasound-guided SLN block can still be used. We also used more cadavers in our experiment (6 bodies, 12 sites) than used by Kaur et al.

One limitation of this study is that the dye we used is different from local anesthetic agents. The different viscosities of methylene blue and local anesthetic agents perhaps will affect the spread area. Although the nerves were bathed well in the dye, the same results may not be obtained when local anesthetic agents are used as the blockade agent. In addition, thawed, frozen tissue may lack elasticity, influencing the spread of the dye and make the spread between live patients and cadaver different. Third, the numbers of studied cadavers were limited. The success rate should not be interpreted universally. It is necessary to perform the study on a larger scale. Finally, the ibSLNs in all cadavers were not visualized. There are many reports revealing that the ibSLN is difficult to visualize using ultrasound [9–11]. The nerve might be too small to be seen using sonography and the resolution of our ultrasonic transducer was not good enough to identify the nerve. A higher resolution ultrasonic transducer might be necessary for SLN identification.

There are few reports of ultrasound-guided ibSLN block. We demonstrated a new method in cadavers. Using ultrasound in the longitudinal orientation to identify the greater horn of the hyoid bone and the thyroid cartilage as landmarks, combined with an out-of-plane technique, may be an alternative method for ultrasound-guided ibSLN block. However, more studies are necessary to prove the reliability of the new method, especially in live patients.

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