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Original Contribution

The thyrohyoid membrane as a target for ultrasonography-guided block of the internal branch of the superior laryngeal nerve☆

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Abstract

Study objective: The objective was to present a proof of concept for a simple and consistently successful ultrasonograpy (US)-guided technique to block the internal branch of the superior laryngeal nerve (iSLN).

Design: This was a volunteer and cadaver anatomy study.

Setting: The setting was an anesthesiology department and an anatomy laboratory at a medical school

Measurements: H13-6 MHz US scans were performed in 40 healthy volunteers positioned supine and with extended necks. The goals were to identify the thyrohyoid membrane, measure its depth (in centimeters) using the shortest vertical distance from the skin, and record the scanning time (in seconds) needed to obtain the optimal image.

Anatomical dissection was performed with an operating microscope bilaterally on 5 adult cadaver heads, fixed in formalin, to expose the point of iSLN penetration through the thyrohyoid membrane. The distance between the greater horn of the hyoid bone and the nerve entry point into the thyrohyoid membrane was measured. Ultrasonography-guided in-plane injections were performed unilaterally with 22-gauge 50-mm nerve block needles in 3 fresh cadavers with 2-mL lidocaine/methylene blue mixture deposited under direct vision just superficial to the thyrohyoid membrane to evaluate technical feasibility and injectate spread.

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Main results: Anatomically, the iSLN was identified in all formalin-preserved cadavers, with hyoid bone greater horn to nerve-membrane interface distances measuring 1.0-2.4 cm (mean, 2.0 cm; SD, 0.5).

Sonographically, the iSLN was not visualized, whereas the hyoid bone and the thyrohyoid membrane were visualized in all volunteers. The mean distance from skin to thyrohyoid membrane was 1.69 cm (SD, 0.38). The mean time needed to scan was 15 seconds (SD, 2.3). After US-guided injection, the dye deposition was observed around the iSLN in all cadaver specimens.

Conclusions: A simpler and consistently reproducible US-guided iSLN block is feasible using the thyrohyoid membrane as target plane for local anesthetic injection. Clinical trials are needed to determine its effectiveness and safety, needle entry point, trajectory, and local anesthetic volume.

1. Introduction

Awake intubation for anticipated difficult airway management using either direct/indirect laryngoscopy or fiberoptic bronchoscopy may be challenging or even fail without proper patient preparation. Excessive salivation, and gag and cough reflexes due to insufficient anesthesia can make intubating conditions difficult if not impossible. In addition, stress and discomfort may cause undesirable surge in sympathetic activity [1]. For effective airway anesthesia, both a topical application of local anesthetics and nerve blocks have been used, with the latter offering superior hemodynamic stability and less patient discomfort [2].

A block of the internal branch of the superior laryngeal nerve (iSLN) provides anesthesia to the base of the tongue, posterior surface of the epiglottis, aryepiglottic folds, and arytenoids [3]. Thus far, various techniques have been suggested. The standard "blind" landmark approach uses the close anatomical relation of the iSLN to the greater horn of the hyoid bone and the thyrohyoid membrane but carries the risk of vessel puncture with hematoma formation or local anesthetic toxicity [4,5].

Ultrasonography (US) has already been applied in assisting the performance of iSLN block, yielding conflicting results. There are studies asserting that iSLN visualization is not possible [6], whereas other studies claim that the visualization of the nerve is possible, although inconsistent and difficult, despite the use of previously suggested landmarks for nerve identification [7,8]. Therefore, a need exists for a safe and consistently successful iSLN block technique that is easy to teach, learn, and perform. The purpose of this study was to develop the anatomical concept for such a technique by sonographically locating the thyrohyoid membrane rather than identifying the nerve itself, and performing a US-guided local anesthetic injection into the target tissue plane.

2. Materials and methods

The local Research Ethics Committee approved this research study.

2.1. Volunteer phase

After obtaining informed consent for the US scanning and measurements, 40 healthy volunteers (male = 20, female = 20, median age = 35.5 years [range, 24–69], median body mass index = 22.57 kg/m^2 [range, 18.37-35.99], mean neck circumference = 33.7 cm [SD, 3.4]) were prospectively included in this study. Exclusion criteria were allergy to US gel, neck pathology, and/or previous surgery. All subjects were placed supine with their necks extended. Ultrasonographic scans were performed by one investigator (JA) in the presence of the lead investigator (TSP), both with considerable US experience, using a high-frequency 13-6 MHz 38-mm linear US transducer (M-Turbo; SonoSite, Inc, Bothell, WA) placed in the midline, over the hyoid bone in transverse orientation, and then moved caudally to observe the thyrohyoid membrane (Fig. 1*A*). Sonographic examinations were recorded, best images saved, and measurements performed only after both participating investigators agreed on image interpretation. The sonographic definitions of the main target landmarks—hyoid bone, thyroid cartilage, and thyrohyoid membrane—had been discussed and agreed upon by all coauthors (JA, KV, EC, TSP) during a separate preliminary pilot phase, including fresh-frozen cadaver US scanning and dissections. The primary goals were to (*a*) identify the thyrohyoid membrane between the hyoid bone and the thyroid cartilage, (*b*) measure its depth (in centimeters) using the shortest vertical distance from the skin to the membrane (white arrow) (Fig. 1*B*), and record the scanning time (in seconds) needed to obtain optimal image.

2.2. Cadaver phase

Anatomical dissections were performed bilaterally with an operating microscope on 5 adult cadaver heads (10 sides) preserved in formalin. After preauricular skin incision, the platysma muscle was removed from the neck and the parotideomasseteric region of the face. Then, the sternocleidomastoid muscle, posterior belly of the digastric muscle, and stylohyoid muscle were reflected posteriorly, whereas the omohyoid and thyrohyoid muscles were reflected medially to expose the point of iSLN penetration through the thyrohyoid membrane. The distance between the greater