Real-time ultrasonographic visualization for guided inferior alveolar nerve injection

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Objective. The purpose of this study was to develop a methodological technique for the ultrasonographic visualization of the inferior alveolar nerve (IAN) using a novel hockey stick–shaped 8- to 15-MHz transducer in volunteers, followed by simulated IAN scanning and injection in cadavers.
Study Design. In 20 volunteers, bilateral scans of the IAN nerve were performed with a systematic technique. We recorded times to scan each side and sonographic visibility of the IAN. In 3 cadavers, bilateral scans of the IAN were performed, followed by simulated injection with dye.
Results. The IAN was visible in all 40 scans. Mean scanning times were 19.6 seconds (range: 4-54 seconds) for the left side and 30.5 seconds (range: 6-116 seconds) for the right side. In 5 cadaver injections, dye was correctly deposited onto the IAN with the ultrasound technique.
Conclusions. We hypothesize that ultrasound-guided IAN block may be feasible in humans using our technique. (Oral Surg Oral Med Oral Pathol Oral Radiol 2013;115:272-276)

The inferior alveolar nerve (IAN) block, also known as the mandibular nerve block, is essential for invasive dental procedures in the mandible, yet it often eludes dental practitioners. Studies measuring the success rate of the IAN block indicate variation depending on the local anesthetic agent used, the volume administered, and the scale used to measure success.[1] The use of a single dental cartridge (1.8 mL) of 2% lidocaine has resulted in a complete block when measured by the electric pulp tester (EPT) up to 71% of the time.[2,3] Infiltration of the mandibular buccal area adjacent to the first molar in addition to the IAN block has elevated the success rate as high as 91%.[4] Few studies show success rates close to 100% when an EPT is used as a measure of success, however, partly because this block is done blindly, solely based on intraoral landmarks, with the confounding factor of anatomical variation.[5] The use of ultrasonography has greatly improved the success of nerve blocks in medicine. In one study the IAN block using ultrasound was described but only the inferior alveolar artery was visible.[6] Since that time, significant improvements to ultrasonography technology have occurred. The purpose of the current study was to develop a technique to visualize the IAN in volunteers using a miniature ultrasound probe, followed by verification with cadaver-simulated IAN injection.

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MATERIAL AND METHODS

Volunteer phase

After receiving ethics approval from the University of British Columbia, we recruited a convenient sample of 20 volunteers. An 8- to 15-MHz hockey stick–shaped transducer (HST15-8/20 linear probe) attached to a SonixTouch ultrasound machine (Ultrasonix, Richmond, British Columbia, Canada) was used to perform the scans, which were all done by 1 investigator (BC). The transducer was placed in a protective barrier that was filled with water, which acted as the conductive medium. Interincisal distance was measured and a bite block was placed to help maintain mouth opening during the scan. The probe was then placed axially along the occlusal mandibular surface against the pterygomandibular raphe and rotated transversely until the ramus was identified. From there, the investigator moved the probe cephalad until the IAN could be visualized by its fascicular appearance (Figure 1). Images of the IAN and inferior alveolar artery were captured and graded on a 3-point scale (0-2) based on their

Statement of Clinical Relevance

This ultrasound-guided technique using a novel hockey stick probe may improve success rates for inferior alveolar nerve injection.

Fig. 1. Ultrasound probe along the left ramus.

Table I. Summary of volunteer demographics

Volunteer demographics (n = 20)	*Mean (SD)*
Age	31.9 years (±7.8)
Weight	71.7 kg (±13.8)
Height	171.3 cm (±8.1)
Interincisal distance	45.6 mm (±6.8)

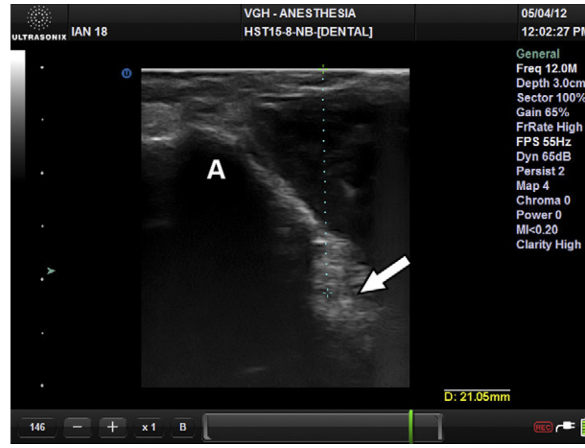

Fig. 2. Ultrasound of the inferior alveolar nerve. "A" indicates the ramus and the arrow indicates the inferior alveolar nerve.

sonographic visibility (0, not visible; 1, equivocal; 2, clear visualization). Each volunteer was scanned bilaterally, producing a total of 40 scans, and scanning times were recorded per side. If volunteers were unable to complete the study, this was noted and these data were included in the analysis. All volunteers were then asked to fill out a simple questionnaire that rated the comfort of the probe compared with the bite block on a 10-point Likert scale anchored at 1 and 10 (1 being not comfortable at all to 10 being very comfortable).

Cadaver phase

Three unembalmed human cadavers were used for this phase of the study in the anatomy laboratory (University of British Columbia). For each cadaver, spandex lip retractors were used to maintain mouth opening and the same 8- to 15-MHz transducer was placed against the medial aspect of the mandibular ramus. Following the identification of the IAN, a 25-g, 40-mm needle on a 5-mL syringe was inserted toward the nerve under ultrasound guidance. With the needle tip adjacent to the nerve, 1 mL of dye was injected and the spread around the nerve was visualized by ultrasound. This procedure was repeated on the contralateral side on each cadaver. To confirm the correct placement of the dye, a blinded anatomist performed a layer-by-layer dissection to the IAN through the skin and the external facial muscles and across the mandibular ramus. Photographs were taken of the dissection and IAN. The injection was deemed successful if the IAN was stained. On the first 2 cadavers, green dye was injected but the spread upon dissection was quite diffuse around the nerve. To more accurately localize the point of injection, 0.5 mL of blue viscous gel was injected on the third cadaver.

RESULTS

Volunteer phase

The demographics of the 20 volunteers (9 female, 11 male) are summarized in Table I. The IAN was easily visualized adjacent to the ramus, as seen in Figure 2. All volunteers completed the study and the IAN was visible in all 40 scans, whereas the inferior alveolar artery was visible in only 6 of 40 scans (Figure 3). The mean scanning time (±SD) was 19.6 ± 14.2 seconds for the left side and 30.5 ± 25.2 seconds for the right side (Table II). The subjective rating of the comfort of the intraoral ultrasound transducer did not differ from that of the bite block ($P = 0.426$). The mean subjective comfort score (±SD) was 7.5 ± 2.1 for the transducer and 7.3 ± 1.7 for the bite block (Table II).

Cadaver phase

The first cadaver was male with a weight of 86 kg and height of 178 cm; the second was female with a weight of 40 kg and height of 175 cm; and the third was female with a weight of 36 kg and height of 155 cm. In all cadavers, with the exception of the left side on the third cadaver, the IAN was identified bilaterally by ultrasonography and had the typical fascicular appearance of nerve tissue (Figure 4). The head on the third cadaver was in a position at death that did not allow for intraoral transducer placement on the left side. After dissection, all 4 IANs were stained with green dye (Figure 5). On the third cadaver, the blue viscous gel was adjacent to the IAN and in the same plane (Figure 6), confirming accurate ultrasonographic identification of the nerve and successful injection.