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CORRESPONDENCE

Injection pressure monitoring at the needle tip for detection of perineural and nerve-contact position: a cadaver study

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To the Editor,

Despite the introduction of ultrasound (US) guidance to aid needle placement for regional anesthesia, neurologic complications continue to be reported after nerve blocks.[1,2] Although US resolution can often determine the needle-tip position in relation to surrounding structures, the US image can sometimes be misinterpreted. As a result, in many cases structures such as the nerve sheath are not clearly visible, or it is simply not possible to clearly visualize the needle tip. This could lead to an unwanted intraneural needle placement and injection. Although the mechanisms of nerve injury after peripheral nerve blocks are not entirely understood, intraneural needle placement should be avoided to prevent possible nerve injury due to intrafascicular injection, direct mechanical damage, and local anesthetic toxicity.

In previous studies, we have described and successfully tested an innovative pressure-sensing needle (Lightsens Medical SA, Bellinzona, Switzerland) that allows continuous and precise monitoring of the injection pressure in tissues and at the needle tip, and therefore is not influenced by the injection parameters.[3,4] We showed how it might be an effective tool to detect accidental intraneural injections while performing peripheral nerve blocks.[5] The device consists of a standard peripheral nerve block needle with a fiber optic pressure sensor at the needle tip level.

Herein, we report an observational cadaver study conducted to determine whether monitoring of injection pressure at the needle tip can discern between needle-nerve contact and a desired perineural injection.

This prospective single-blinded cadaveric trial was conducted at the Iclo Teaching and Research Centre (Verona, Italy). Fresh frozen cadavers were acquired from donors who donated their body to science, and their handling, conservation, and use were in accordance with local regulations. Four senior anesthesiologists performed injections under real-time US guidance on four fresh cadavers (three lower and one upper body parts) using a sensing needle adapted from a SonoPlex 22G x 80 mm needle (Pajunk GmbH, Geisingen, Germany). Another investigator responsible for data analysis was blinded to the position of the needle tip. A total of 48 US-guided injections of 1 mL normal saline at 10 mL·min^{-1} using an automated pump were performed. Four injection locations were used: subgluteal, mid-thigh, popliteal sciatic, and interscalene brachial plexus. For each location, six perineural injections and six subsequent needle-nerve

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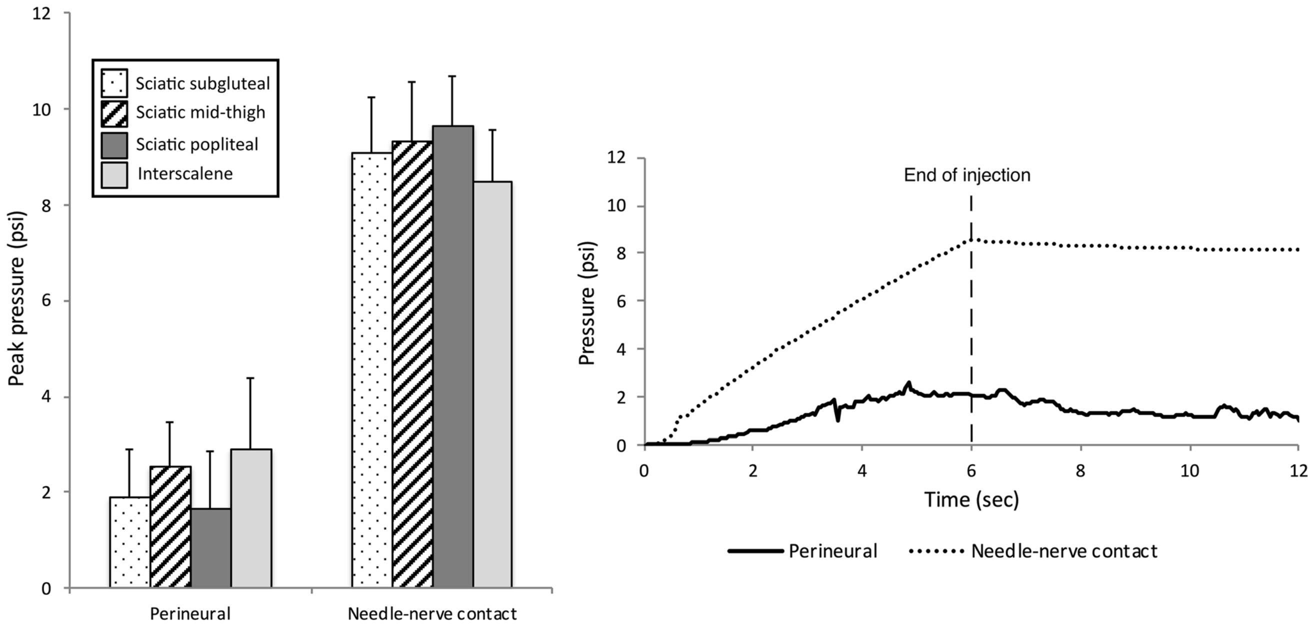

Figure Mean (standard deviation) needle-tip peak injection pressures of the four injection locations (left). Example of real-time tip pressure monitoring of perineural and needle-nerve contact injections in sciatic mid-thigh nerve. 1-mL injection at a controlled infusion rate of 10 mL·min^{1} (right).

contact injections were performed. While an anesthesiologist injected, the three other investigators confirmed the needle tip location on the US monitor.

All US-guided injections were successfully performed. No technical failure of the equipment occurred and in all cases the injection pressure curve was successfully recorded. One subgluteal procedure (a perineural and a needle-nerve contact injection) was excluded from the analysis because the anesthesiologists could not confirm the exact needle tip position from the US image. The mean (standard deviation) peak injection pressure was significantly higher for needle-nerve contact compared with perineural injections [9.1 (1.1) *vs* 2.3 (1.2) psi, respectively; mean difference, 6.8; 95% confidence interval, 6.1 to 7.5; $P < 0.001$]. Perineural injections in all nerves show a consistently low-pressure profile (Figure, left), where all the perineural injections resulted in a pressure lower than 5 psi. The difference is also evident on real-time pressure curve profiles, as an injection against the nerve produces a high and fast-rising profile, potentially constituting a very effective visual alert to a clinician (Figure, right).

In conclusion, our findings suggest that monitoring injection pressure at the needle-tip may distinguish between perineural and needle-nerve contact position. This could alert the practitioner to stop further advancement of the needle and to safely inject perineurally, thus preventing possible damage due to intraneural needle placement and injection. A pressure threshold of 5 psi at the needle tip, as obtained using a sensing needle, might be an adequate safety target to avoid nerve-contact position.

Conflicts of interest Christian Quadri and Andrea Saporito are listed as inventors of a patent application entitled "Needle for a syringe, syringe and corresponding control system".

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