



A laser mount probe holder facilitates fixation of the optimized ultrasound image and needle alignment in-plane to the ultrasound beam during ultrasound-guided peripheral nerve block

Yoshimune Osaka¹ · Yoshihisa Morita¹

Received: 10 May 2019 / Accepted: 13 July 2019 / Published online: 19 July 2019
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Abstract

Laser guidance facilitates needle alignment in-plane to the ultrasound beam. Once the ultrasound image is optimized, there is no further need to maneuver the probe. Therefore, we designed a laser mount probe holder prototype, and examined the ease of visualization of the needle tip using the laser mount probe holder. The needle brightness was quantitatively measured using an image analysis software. We found that the laser mount probe holder is useful, not only to visualize the needle tip in the ultrasound plane, but also to fix the best ultrasound image.

Keywords Optimized image · Probe stabilization · Laser guidance · Needle tip visualization

To perform ultrasound-guided (US) peripheral nerve block (PNB) safely, probe maneuvering such as “PART” is recommended to obtain better US images [1]. However, probe maneuvering to visualize the needle may make it difficult to retain the optimally adjusted image. One of the technical difficulties of USPNB is proper needle visualization in the US field of view. In particular, a tilted position of the probe makes it difficult to visualize the entire length of the needle shadow in the US field of view. Use of a needle guide is helpful to visualize the needle tip in such cases [2–5], but this only works when the puncture site is near the probe. Laser guidance facilitates needle alignment in-plane to the US beam even when the puncture site is far from the probe, because the laser line shows the US plane [6, 7]. In addition, once the US image is optimized, there is no further need to maneuver the probe. The probe stabilized with the probe holder can keep the “best” US image fixed. Therefore, we designed a laser mount probe holder prototype as previously reported [8].

We examined the ease of visualization of the needle tip using this self-made laser mount probe holder [8] (Fig. 1)

for a linear probe (S-Nerve HFL50x/15-6™, FUJIFILM Medical Co., Ltd., Tokyo, Japan). The probe was placed vertically with reference to the phantom (Blue Phantom™, Gadellius Medical Co., Ltd., Tokyo, Japan) and the needle was inserted far from the probe, in-plane, up to a depth of 2 cm (Fig. 1a) at the center of the US field of view by a single operator; the needle insertion was carried out alternately with and without the use of the laser guide, five times each. We also examined the case where the probe was applied at an angle of about 45° to the phantom surface (Fig. 1b) in the same manner. To evaluate the visibility of the needle, the brightness of the needle shadow in the US field of view was quantified using an image analysis software (Image J, Version 1.51, National Institutes of Health, Bethesda, Maryland, USA, <http://imagej.nih.gov/ij/>, 1997–2012.), based on 256-level gray values of the pixels (0: black, no light at all, 255: white, state where all the light is maximized). For the statistical analysis, Student’s *t* test was performed using R. The statistical significance level was set at $p < 0.05$.

The brightness when the probe was applied vertically was 235 ± 21 with laser guidance, and 117 ± 28 without laser guidance ($p < 0.001$). The brightness when applied at an angle of about 45° was 222 ± 25 with laser guidance, and 82 ± 2 without laser guidance ($p < 0.001$).

Better visualizability of the needle tip was obtained with the use of the laser mount probe holder. The brightness of the needle shadow in-plane represents the accuracy of the insertion plane.

✉ Yoshimune Osaka
bluesapphire1226@gmail.com

¹ Department of Anesthesiology, Kawasaki Municipal Hospital, 12-1 Shinkawa Street, Kawasaki-ku, Kawasaki, Kanagawa 210-0013, Japan

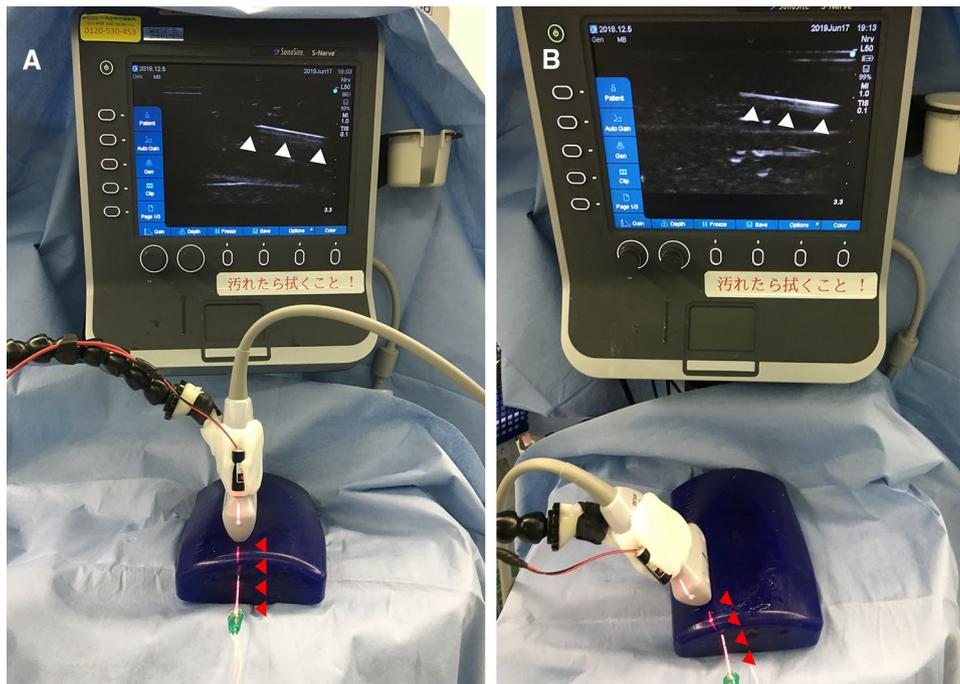


Fig. 1 **a** The probe was placed vertically to the phantom and the needle was inserted far from the probe in-plane, up to a depth of 2 cm, with or without laser guidance. **b** The probe was applied at an angle of about 45° to the phantom and the needle was inserted in the same manner. The laser mount probe holder device consists of three parts, the flexible arm (Flexible arm™, PROKIZAI.COM Co., Ltd.,

Okinawa, Japan), the probe holder, and the laser module (Line laser module™, Denshi Tusho Co. Ltd., Tokyo, Japan). The laser navigation and the probe holder are mounted on the flexible arm using deformable plastic (Moldable Plastic™, TfabWorks, Chiba, Japan). The white arrow in the ultrasound image shows the needle shadow, and the red arrows shows the laser beam overlapping the needle

The conventional needle guide is useful only when the insertion site is in close vicinity to the probe; it is ineffective when the insertion site is far from the probe, as in the case of the popliteal approach from the outside, or the shamrock approach. Furthermore, tilting of the probe is often needed to direct the US beam in a direction perpendicular to the structures during USPNB. In such cases also, it is difficult to visualize the needle using the conventional needle guide. Better visualizability of the needle tip was obtained under laser guidance, which was even more remarkable when the puncture was executed at an angle of 45°.

We consider the laser mount probe holder as a very useful device for the following reasons. First, the laser guidance is of great help to know the plane of the US beam. Second, the fixation of the probe with the probe holder reduces the risk of change of the US image at the time of insertion. Maneuvering the probe to visualize the needle properly during needle insertion could lead to unwanted outcomes. Furthermore, use of the probe holder allows a single person to maneuver the needle and inject the local anesthetic. This is particularly useful during catheter insertion.

As a limitation, we conducted this study on a phantom rather than on a human. The entrapped air in the phantom after the needle insertion could have affected the brightness

of the US image. In addition, there are disadvantages of the device being handmade. However, we consider that laser guidance is useful for recognizing the US plane and the probe holder is useful for fixing the best US image by the stabilized probe.

In conclusion, the laser mount probe holder is useful not only to visualize the needle tip in the US plane, but also to fix the best US image.

Author contributions YO: This author designed and performed this study and wrote the manuscript; YM: This author helped in the preparation of the final manuscript, in responding to the critical comments, and in obtaining the final approval.

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