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Lymphatic Mapping for LVA with Noncontrast Lymphatic Ultrasound: How We Do It

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Summary: Recently, lymphatic ultrasonography has received increasing attention. Although there are several reports on contrast-enhanced lymphatic ultrasound as a preoperative examination for lymphaticovenous anastomosis (LVA), we have been reporting the usefulness of preoperative noncontrast lymphatic ultrasound. In this article, the detailed procedure for conducting lymphatic ultrasound during the preoperative examination of LVA is thoroughly described. The only items required for lymphatic ultrasound are an ultrasound device, an echo jelly, a straw for marking, and a marker. We use an ordinary ultrasound device with an 18-MHz linear probe. We apply the Doppler, Crossing, Uncollapsible, Parallel, and Superficial fascia index to identify the lymphatic vessels. While imagining the course of the lymph vessels, we position the probe perpendicular to the long axis of the lymphatic vessels. When a vessel is found under the superficial fascia, the probe is moved proximally to trace the vessel's path. If the vessel transverses a nearby vein without connecting to it, it is most likely a lymphatic vessel. To confirm, we ensure that the vessel does not exhibit coloration in the Doppler mode. As LVA is most effective when the dilated lymph vessels are anastomosed, we use lymphatic ultrasound to identify the most dilated lymphatic vessels in each lymphosome, and mark incision lines where suitable veins are in close proximity. No contrast agent is required; therefore, medical staff such as nurses and ultrasound technicians can autonomously conduct the test. *(Plast Reconstr Surg Glob Open 2024; 12:e5739; doi: 10.1097/GOX.0000000000005739; Published online 15 April 2024.)*

TECHNIQUE OF LYMPHATIC ULTRASOUND

Recently, lymphatic ultrasonography has received increasing attention in treatment for lymphedema. Since 2022, several reports have detailed the use of contrast-enhanced lymphatic ultrasound as a preoperative examination for lymphaticovenous anastomosis (LVA).[1] Conversely, we have been reporting the usefulness of preoperative noncontrast lymphatic ultrasound since 2017.[2] Noncontrast lymphatic ultrasound is a noninvasive and innovative method that does not require any contrast agent or special equipment. It is also useful for diagnosing lymphatic degeneration or for real-time observation of lymphatic vessel dynamics.[3–6]

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We diagnose lymphedema using lymphoscintigraphy in the outpatient clinic, and LVA is indicated when well-functioning lymph vessels are detected. If lymphatic vessels are not detected on lymphoscintigraphy, such as type 4 or 5 in the Maegawa classification,[7] screening is performed using lymphatic ultrasound; if dilatated lymphatic vessels are detected, LVA is indicated. Approximately half of the patients undergo indocyanine green (ICG) lymphography preoperatively. For the remaining patients allergic to iodinated contrast agents or at high risk of cellulitis, ICG lymphography is omitted, and lymphatic vessels are detected using lymphatic ultrasound alone.

The only items required for lymphatic ultrasound are an ultrasound device, an echo jelly, a straw for marking, and a marker [**see Video 1 (online)**]. We use an ordinary ultrasound device (Noblus EUP-L65, Hitachi Medical Corp., Tokyo, Japan) with an 18-MHz linear probe (Fig. 1). The preset is "superficial," enabling clear visualization of superficial blood vessels. For the lower limbs, the depth is set to 2–2.5 cm, and the focus is set to approximately

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1 cm. [**See Video 1 (online)**, which shows the preparation, necessary items, and method for lymphatic ultrasound.]

We apply the Doppler, Crossing, Uncollapsible, Parallel, and Superficial fascia (D-CUPS) index to identify the lymphatic vessels. **[See Video 2 (online)**, which shows the lymphatic ultrasound.] While imagining the course of the lymph vessels (Fig. 2), we position the probe perpendicular to the long axis of the lymphatic vessels. When a vessel is found under the superficial fascia, the probe is moved proximally to trace the vessel. If the vessel crosses a nearby vein without joining, it is most likely a lymphatic vessel (Fig. 3). To confirm, we ensure that the vessel is not colored in the Doppler mode.

Lymphatic vessels are known to degenerate in lymphedema-affected limbs (Normal, Ectasis, Contraction, and Sclerosis Type classification), and LVA is most effective when the dilated lymph vessels are anastomosed.[8] Therefore, we first identify the most dilated lymphatic vessels in each lymphosome using lymphatic ultrasound. Next, we search for a suitable vein, and determine the incision site where the dilated lymphatic vessel and vein are within 1 cm apart. A disposable straw is pressed against the skin to make a mold (Fig. 4). The jelly is then wiped off, and the skin incision line is marked using the marker.

A single examiner can execute all steps. No contrast agent is required; therefore, medical staff such as nurses and ultrasound technicians can autonomously perform lymphatic ultrasound.

Takeaways

Question: How do you perform noncontrast ultrasound lymphography for the preoperative mapping for lymphaticovenous anastomosis (LVA)?

Findings: The preparation, procedures, and precautions for noncontrast lymphatic ultrasound for preoperative examination of LVA. Video tutorials are also included.

Meaning: Noncontrast lymphatic ultrasound is a safe examination that can be performed at any medical institution. It is also an efficient examination that allows simultaneous observation of the lymphatic vessels and veins used for LVA.

DISCUSSION

In this article, we present a detailed method for performing noncontrast lymphatic ultrasound as a

Fig. 1. Ultrasound device used for lymphatic ultrasound. No special probe is necessary for lymphatic ultrasound, and it can be performed using ultrasound device and linear probes found in general medical facilities.

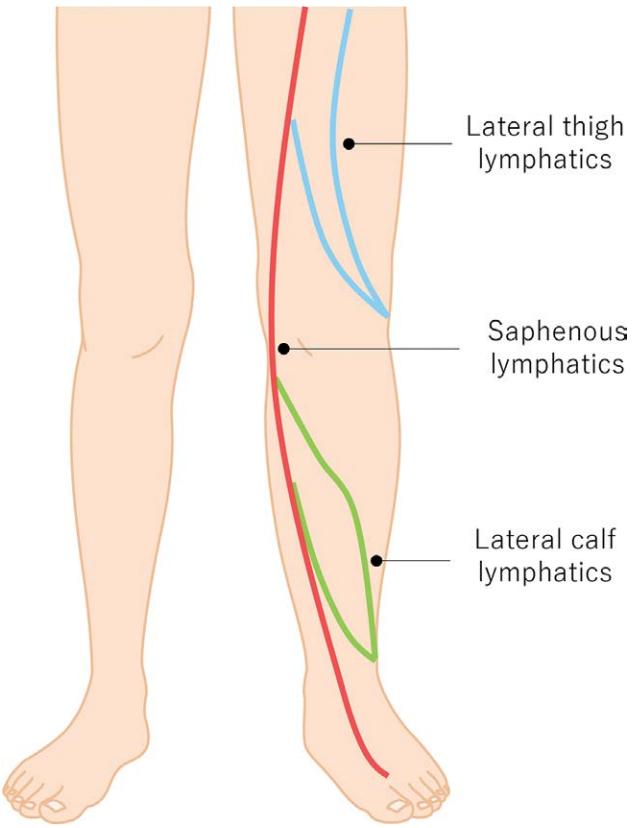

Fig. 2. Schema of the lymphatic vessels of the lower limbs. While imaging the course of the lymph vessels, we positioned the ultrasound probe on the skin perpendicular to the long axis of the lymph vessels.

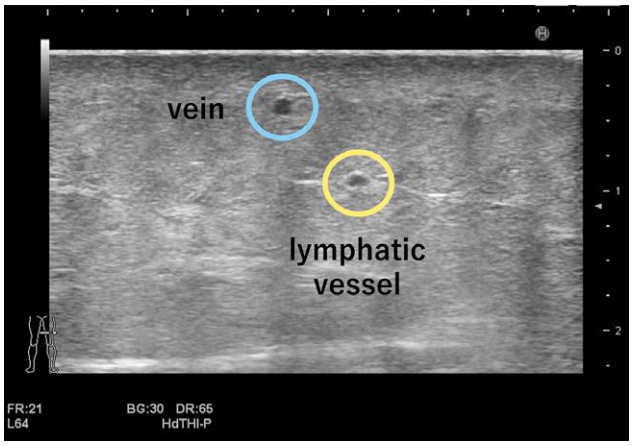

Fig. 3. Lymphatic ultrasonographic image of the lateral thigh in the lymphedematous limb. A dilated lymph vessel and a vein suitable for lymphaticovenous anastomosis are found in close proximity. With one probe, both lymphatic vessels and veins can be observed simultaneously.

Fig. 4. Marking of the skin incision site for lymphaticovenous anastomosis. Due to the involvement of the echo jelly, using a magic marker is not feasible; therefore, we first press a straw against the skin to make a straw mold. Subsequently, we wipe off the jelly and mark using a marker.

preoperative examination for LVA. Noncontrast lymphatic ultrasound has the advantages of not requiring a contrast agent, can be easily performed in an outpatient setting or at the bedside, and can be performed by a single examiner.

Currently, contrast-enhanced lymphatic ultrasound requires a special probe with a maximum frequency of 15 MHz. Therefore, switching to a higher-frequency probe is necessary to identify superficial veins for LVA.[9] Noncontrast lymphatic ultrasound is more efficient because lymphatic vessels and veins can be examined simultaneously using a single probe. Additionally, high-frequency probes have a better resolution; therefore, they have the advantage of being able to accurately diagnose lymphatic degeneration.

In recent years, there have been developments in ultrahigh-frequency echo probes, including those operating at 33 MHz or 70 MHz. However, when dealing with lower limb lymphedema, it is generally considered that a frequency of approximately 18 MHz is the most optimal choice for imaging purposes.

Conventional examinations such as lymphoscintigraphy or ICG lymphography cannot diagnose the degree of degeneration of each lymphatic vessel.[7] By using lymphatic ultrasound, a cross-section of the lymphatic vessels can be observed, making it possible to diagnose lymphatic degeneration noninvasively with a high resolution.[5] This is useful both in preoperative examination for LVA and in diagnosing lymphedema.[6]

In patients who undergo ICG lymphography, lymphatic ultrasonography is performed using a line marked on the skin as a reference. In many cases, a dilated lymphatic vessel found on lymphatic ultrasound is located a few centimeters away from the line on ICG lymphography. We perform LVA with priority for dilated lymph vessels found on lymphatic ultrasound. Jang et al reported that the lymph vessels detected by ICG lymphography and those detected by contrast-enhanced lymphatic ultrasound sometimes coincide.[9] This should be the difference between contrast-enhanced and noncontrast ultrasound. As Yang et al have reported, LVA is effective even when anastomosing lymph vessels that are not enhanced during ICG lymphography.[10]

Noncontrast lymphatic ultrasound presents a drawback in requiring the examiner to attain some proficiency in distinguishing the lymphatic vessels. The skills necessary for lymphatic ultrasound can be delineated into two categories: one involves the proficiency in visualizing blood vessels using ultrasound, whereas the other involves the ability to discriminate between lymphatic vessels and veins. The former resembles to the routine practice of lower limb venous ultrasound, predominantly centered on the examination of major superficial veins, such as the great saphenous vein. Concerning the latter, we recommend practicing on lymphedematous limbs because the lymphatic vessels in healthy limbs are remarkably thin, 0.2 mm in diameter. In contrast, in limbs afflicted by lymphedema, lymphatic vessels typically exhibit dilations within the range of 0.5–1.0 mm. Even nurses who have little experience with ultrasound images will be able to identify which are lymphatic vessels in the ultrasound monitor after observing for about 30 minutes. If ultrasound technicians who are used to observing blood vessels in the extremities using echocardiograms practice ultrasound with about five lymphedema patients, they will be able to perform lymphatic ultrasound.

Lymphatic ultrasound holds promise for broader adoption as a preoperative examination for LVA and as a diagnostic tool for lymphedema.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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