Ultrasound / Interview report

Clinical usefulness of Canon diagnostic ultrasound systems in the management of patients with lymphedema

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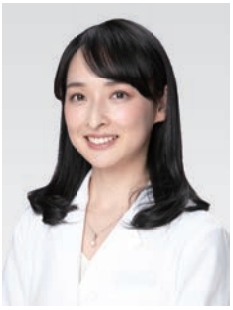

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Introduction

Lymphedema develops in 20% to 30% of patients who have undergone surgery for breast cancer or uterine cancer. It can lead to left-right asymmetry and swelling of the arms and legs, as shown in the image (Fig. 1). It is clear that lymphedema has a significant impact on patients' quality of life and can severely disrupt their daily activities. Patients may have difficulty walking and some may also withdraw from society and stay at home because they feel embarrassed about their physical appearance or because they are unable to wear the same clothing they previously wore. Approximately 100,000 to 150,000 people in Japan suffer from symptoms associated with lymphedema.

It has been reported that lymphedema can be successfully managed by employing both conservative and surgical treatment, an approach known as combination therapy. This includes compression therapy, manual lymphatic drainage, exercise therapy with compression, and weight control. The team at our hospital is providing care to nearly 2,000 patients with lymphedema, and we perform 400 lymphaticovenous anastomosis (LVA) procedures every year. We are currently focusing on the treatment of lymphedema incorporating the use of diagnostic ultrasound. In this report, we would like to describe the clinical usefulness of ultrasound in patients with lymphedema and also discuss why we use ultrasound systems manufactured by Canon Medical Systems.

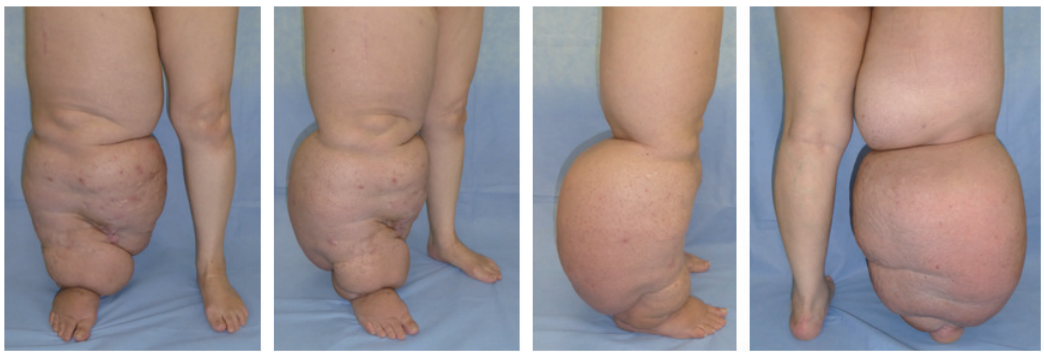


Figure 1 Lymphedema case images (Pre-treatment)

Challenges before the introduction of ultrasound examination

In routine practice

With accurate examination and proper treatment, swelling of the arms and legs caused by lymphedema can be substantially reduced, allowing patients to resume a healthy and active lifestyle. Lymphoscintigraphy can be used to diagnose lymphedema, but this examination requires special equipment which is only available at a limited number of facilities in Japan. So even if a patient who is worried that they might have lymphedema visits the hospital, it may not be possible to make a definitive diagnosis. Lymphedema is therefore often a diagnosis of exclusion to explain the patient's clinical symptoms. Another method for examining the lymphatic system is ICG fluorescence lymphangiography. Both of these diagnostic imaging methods are based on visualizing a contrast agent that has been injected into the lymphatic system. Both therefore suffer from limitations in functional evaluation, especially in patients with impaired lymphatic function, because lymphatic vessels cannot be visualized if the contrast agent fails to reach them. In addition, patients may be reluctant to undergo these examinations because injection of contrast agent is associated with the risks of pain and allergic reactions, and medical professionals may be reluctant to strongly recommend these examinations for the same reasons.

In surgical procedures

When performing LVA, it is essential to first identify the lymphatic vessels that are in good condition before making the skin incision. Healthy lymphatic vessels are thin vessels about 0.2 mm in diameter, but in extremities affected by lymphedema, the lymphatic vessels may expand to 0.5 to 1 mm in diameter due to impaired lymphatic drainage. When lymphatic vessels are subjected to these abnormal conditions for an extended period, wall thickening may develop, leading to hardening and occlusion of the vessels (as seen in atherosclerosis). Before performing LVA, it is essential to identify these dilated lymphatic vessels. Conventional lymphoscintigraphy or ICG fluorescence lymphangiography can be used to visualize the location of the lymphatic vessels relative to the body surface, but these methods are less useful for evaluating the depth, thickness, abnormality, expansion, or stiffness of the vessels, limiting their usefulness as preoperative examinations prior to LVA.

Changes in clinical practice following the introduction of ultrasound

In routine practice

One of the most significant benefits we have noted since the introduction of ultrasound is that examinations can be performed more frequently. In the past, examinations of the lymphatic vessels required invasive procedures such as the injection of contrast agent, with the associated risks of pain and allergic reactions. Patients may have second thoughts immediately before such examinations are to be started, and medical staff may hesitate to perform examinations in such cases. Ultrasound examinations, on the other hand, are painless and can be performed anywhere in the hospital, such as in outpatient clinics and patient wards. Ultrasound systems have also advanced to the point that image findings can be viewed together with the patient, allowing patients to gain a clearer understanding of the condition of their lymphatic system and the severity of lymph retention. While viewing the ultrasound images together, the patient and the physician can undertake treatment with shared expectations and goals.

There is often a mismatch between the subjective impressions of the patient and the objective findings of the physician in terms of the location and extent of edema. Patients with lymphedema often have increased amounts of fibrous and fatty tissues as well as lymph retention, so it is important to accurately identify the reasons for enlargement of the affected extremity in order to formulate an effective therapeutic plan (Fig. 2). Some patients may also misinterpret natural aging related body shape changes as signs of edema. Before the introduction of ultrasound, we tried to resolve any mismatch between the perceptions of patients and observations of physicians by giving detailed verbal explanations, but this approach was not always effective. With ultrasound, patients and physicians can reach a mutual understanding while viewing the same images together as a shared experience, allowing treatment to proceed with confidence (Fig. 3).

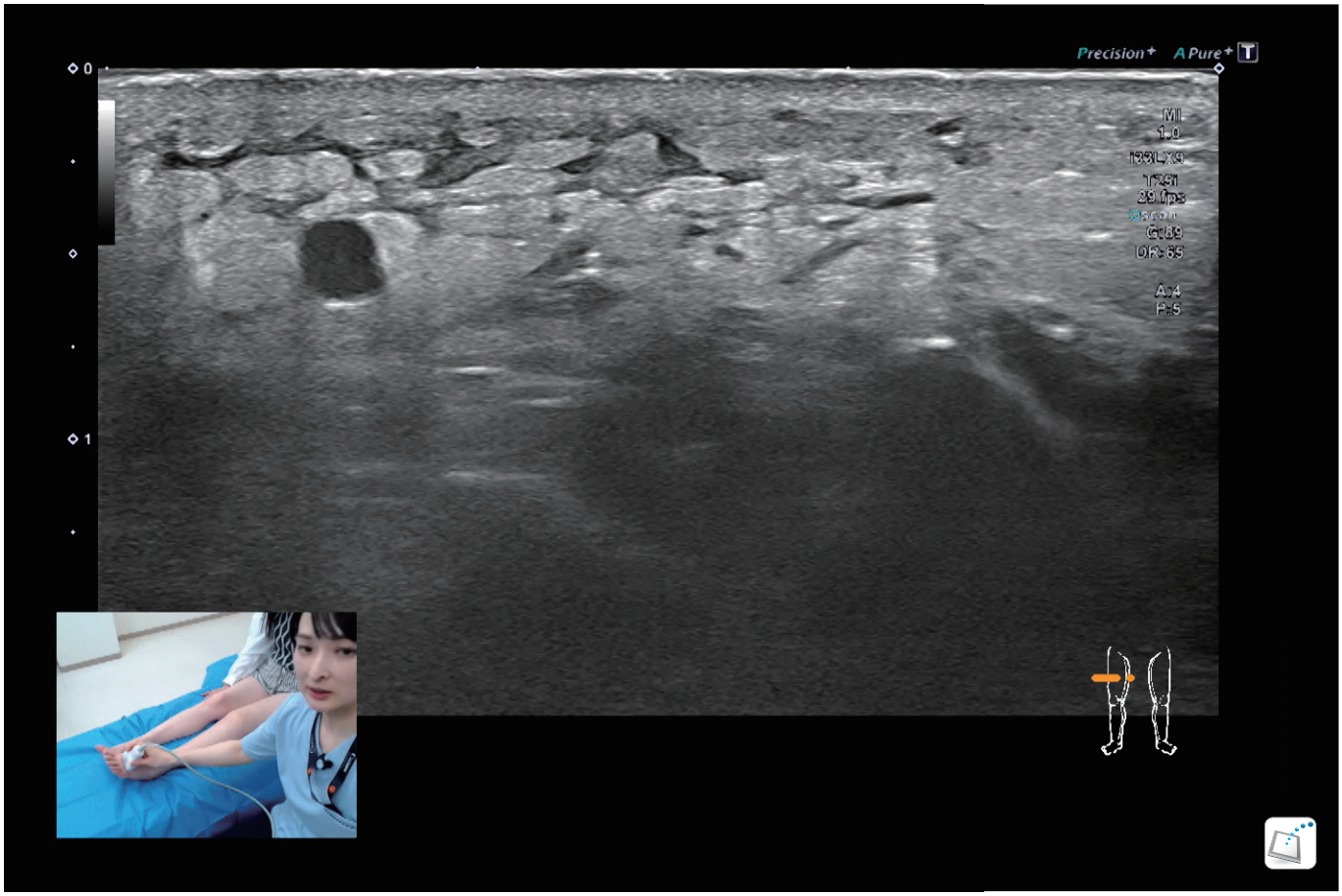


Figure 2 Ultrasound image of lymphedema patient has lymphatic effusion in the fat layer

Figure 3 Viewing images in real-time with the patient

In surgical procedures

The introduction of ultrasound has dramatically improved surgical procedures. In the past, when lymphatic vessels could not be identified by lymphoscintigraphy or ICG fluorescence lymphangiography before surgery, it was necessary for the surgeon to visually search for the lymphatic vessels and veins during the surgical procedure itself. It would sometimes take as long as 40 minutes to find the lymphatic vessels after making the incision, and in some cases, the lymphatic vessels could not be found at all. With the use of ultrasound, the locations of the veins and lymphatic vessels can be accurately identified in advance and information concerning the status of the lymphatic vessels can also be obtained. This helps to ensure safer and more effective surgical procedures. It is important to perform LVA using lymphatic vessels that are not too stiff or expanded, so the ability of ultrasound to accurately show the status of the lymphatic vessels is of great value. With ultrasound, we can find the target veins and lymphatic vessels within 5 to 10 minutes after making the incision. We have also been able to reduce the number of shunts from about 10 shunts in conventional procedures to about 3 shunts in ultrasound procedures, while achieving equally good treatment outcomes. In addition, the time required for these surgical procedures has been reduced to about 1/3, further relieving the physical burden on patients. Another benefit of ultrasound is that patients can enter the operating room with a greater sense of confidence and less emotional stress because they were able to observe their own veins and lymphatic vessels beforehand. With this greater sense of confidence, patients can actually view microscope images during the procedure and see the veins and lymphatic vessels as they are being anastomosed to create shunts, giving them a clearer understanding of how their symptoms will be improved by the surgery. Since the introduction of ultrasound in our therapeutic approach, we have noted remarkable reductions in patient anxiety.

Future prospects of ultrasound in evaluating patients with lymphedema

Another important benefit of ultrasound is that examinations can be performed not only by physicians, but also by other medical professionals such as nurses, physical therapists, and cardiovascular technologists (CVTs).
In particular, CVTs, who have undergone specialized training to perform ultrasound examinations of blood vessels in the lower extremities and other regions, have specialized skills which should also allow them to perform detailed examinations of the lymphatic vessels.

I think the time will soon come when the evaluation of patients with lymphedema, which was previously possible at only a few medical facilities offering lymphoscintigraphy or ICG fluorescence lymphangiography, will become possible at the many medical facilities where ultrasound systems are available. When a patient begins to worry or experience discomfort due to lymphedema, ultrasound provides a very easy way to evaluate the patient's condition. The early diagnosis of lymphedema can help to ensure that patients receive appropriate treatment without delay and thus prevent the progression of symptoms. It is my belief that the use of ultrasound will allow postoperative breast cancer patients and postoperative gynecologic cancer patients to lead happier and more active lives with fewer worries concerning lymphedema.

Advantages of the diagnostic ultrasound systems manufactured by Canon Medical Systems

Image quality

When a 33-MHz transducer (PLI-3003BX) is used, even extremely fine lymphatic vessels in superficial tissues can be visualized with outstanding clarity. The subcutaneous tissues are quite thin in the dorsum of the foot and in the upper extremities, and the lymphatic vessels may be located only about 5 mm below the skin surface. In such areas, it was often difficult to visualize the lymphatic vessels even with the use of an 18-MHz transducer (PLI-1205BX), which was previously considered to be a high-frequency transducer, and plans for surgical treatment often had to be abandoned (Fig. 4). But with the PLI-3003BX 33-MHz transducer, these superficial lymphatic vessels can be very clearly visualized, allowing the lymphatic vessels to be evaluated in detail for diagnosis as well as surgical planning (Fig. 5). It is now possible to perform surgery in many more patients thanks to ultrasound's outstanding capabilities in clearly depicting the lymphatic vessels, resulting in marked improvements in our patients' quality of life.

Superb Micro-vascular Imaging (SMI)

We also frequently employ Canon Medical's SMI functions. With conventional Doppler mode, it is often impossible to distinguish between tissue motion (motion artifact) and low-velocity blood flow in small veins such as those used for LVA. Therefore, very often, veins could not be detected and differentiated from lymphatic vessels. With SMI, however, blood flow information can be displayed even for small veins, which were previously difficult to depict, making it easier to distinguish them from lymphatic vessels (Figs. 6-7). Therefore, the use of SMI has made it possible to quickly and accurately differentiate between lymphatic vessels and veins, which is necessary for preoperative examinations of LVA.

High-frequency linear transducer PLI-3003BX

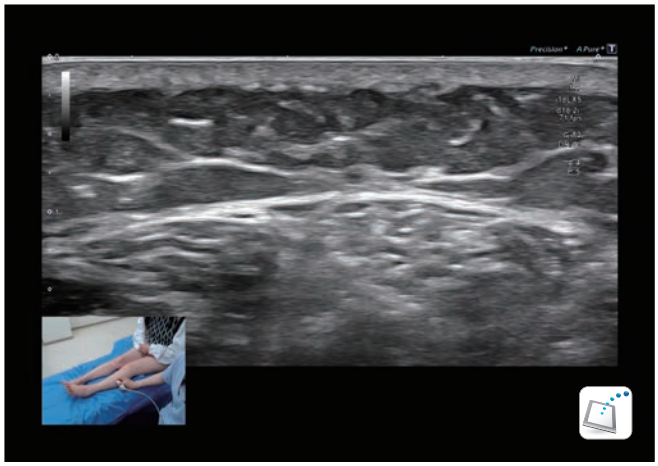


Figure 4 Ultrasound image of lymphedema patient (PLI-1205BX)

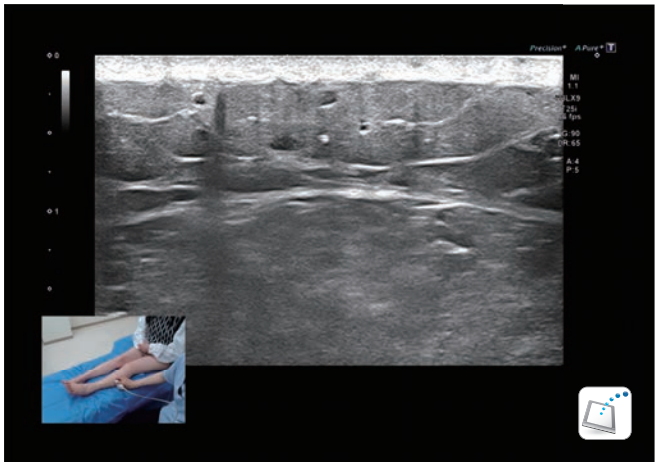


Figure 5 Ultrasound image of lymphedema patient (PLI-3003BX)

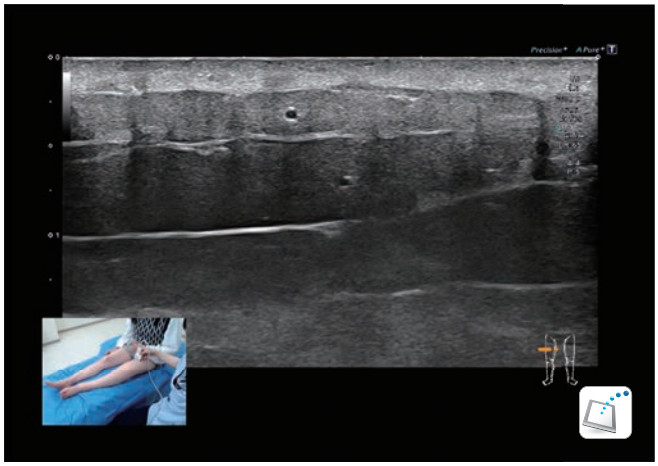


Figure 6 Ultrasound image of lymphedema patient (without SMI) showing veins and lymphatic vessels on one screen (PLI-3003BX)

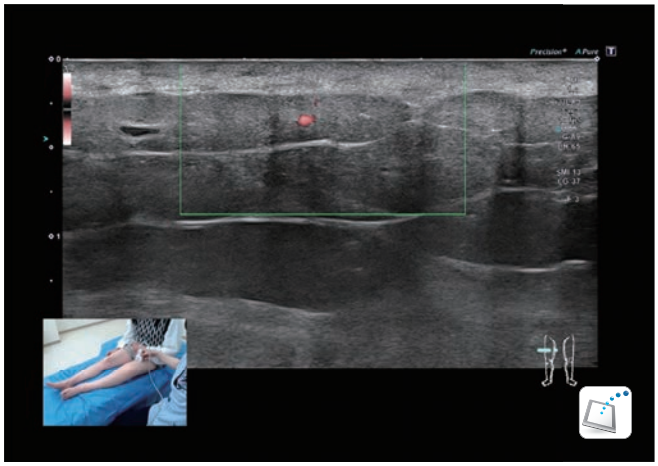
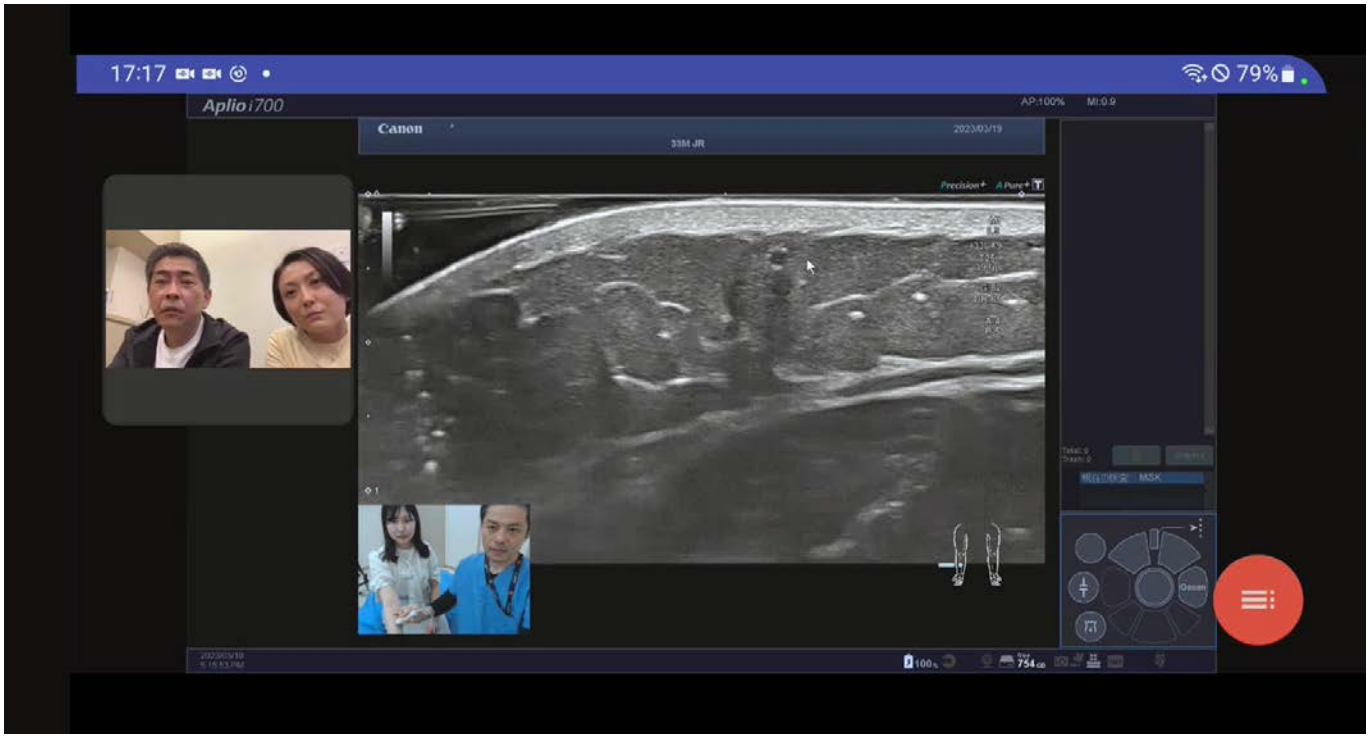


Figure 7 Ultrasound image of lymphedema patient (with SMI) only veins are colored (PLI-3003BX)

ApliCam and ApliGate

One of the main disadvantages of conventional ultrasound examinations is that when ultrasound images are viewed at a later time, it is often difficult to determine the directions from which the images were acquired. In addition, the quality of the acquired images tends to vary depending on the operator's skill. We sometimes need to ask patients to visit our hospital for repeat ultrasound examinations because the images acquired at other people cannot be interpreted. This problem can be avoided by acquiring videos with ApliCam. These videos provide much more information than simple body marks. Because the movements of the transducer are recorded in real time during scanning, examinations of the same region can be performed with higher reproducibility and the acquired images can be interpreted more easily when they are reviewed later. In addition, ApliCam is extremely helpful when discussing cases with medical staff who were not present during the examination.

We are also looking forward to expanding the use of ApliGate. In the past, ultrasound examinations involved only the operator and the patient. But when ApliGate is used, the dynamic images acquired during an examination can be shared in real time with the patient's family members and primary care physician at remote locations. We are confident that ApliGate will help us provide an even higher level of medical care.



Ultrasound images are being shared remotely using ApliCam and ApliGate

Challenges and future prospects

I believe that ultrasound examination of the lymphatic vessels will soon become accepted as a standard examination option in the management of patients with lymphedema. Venography may serve as an illustrative example. In the past, venography was one of the standard examination methods for evaluating diseases of the lower extremities. At that time, ultrasound examination of the veins of the lower extremities suffered from poor reproducibility. But today, ultrasound is widely employed as a standard examination method for diseases of the lower extremities. ApliCam and ApliGate are now available in the diagnostic ultrasound systems manufactured by Canon Medical Systems, and I look forward to using these advanced functions to conduct hands-on seminars with medical professionals at remote locations. We hope to standardize lymphatic ultrasound and thus further expand the usefulness of ultrasound in the management of patients with lymphedema as well as other types of edema. I also believe that ultrasound can serve as a bridge between patients and medical professionals. Ultrasound examinations are painless and easy to perform. It is also possible for patients and medical professionals to view the same images together in real time. Furthermore, by connecting people via the internet using ApliCam and ApliGate, diagnostic information can be shared with the patient's family members and primary care physician, as well as other physicians who may not be specialists in the care of patients with lymphedema. We believe that by carefully evaluating and fully employing diagnostic ultrasound systems on a regular basis, we can deepen mutual understanding between patients and medical professionals. Using ultrasound as a bridge, we can all work together as a team to achieve our shared healthcare goals.

How to Use the medicalAR App

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1. Launch the app and start AR Camera.
2. Scan the whole page, including an image with the icon.
3. When the trigger image is captured, the linked contents will be displayed.

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