Schliere Phenomenon for Identification of Lymphorrhea Point

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Summary: Surgical invasion of the lymphatic system can lead to lymphorrhea. Lymphorrhea is first treated conservatively, but is often refractory and subsequently treated surgically. In surgery, it is difficult to identify the lymphatic leak points visually. In this study, we observed the schliere phenomenon based on the difference in the refractive index between glucose solution and lymph fluid, and were able to easily identify the site of the lymphatic leakage in real time and treat lymphorrhea. (Plast Reconstr Surg Glob Open 2022;10:e4269; doi: 10.1097/GOX.0000000000004269; Published online 18 April 2022.)

INTRODUCTION

Lymphorrhea is one of the postoperative complications of surgical invasion of the lymphatic system. When conservative treatment fails, surgical treatment is usually performed after identifying the site of lymphorrhea, using lymphoscintigraphy or indocyanine green (ICG). Surgical procedures include lymphatic vessel ligation, fibrin glue application, and lymphaticovenular anastomosis. Lymphatic fluid is colorless and transparent, making intraoperative exact identification of lymphatic leak points difficult; therefore, ICG is usually used. ICG requires an infrared camera system, making it difficult to visualize directly in the operative field in real time unless digital technology is used. In addition, ICG adheres to the surgical field, and observation becomes more difficult with time (Fig. 1). The schliere phenomenon is a phenomenon in which a striped pattern or a misty shadow appears in a transparent medium when the refractive index differs from place to place. In this study, we report that the use of dextrose solution can easily reveal the point where the lymphatic fluid leaks from the lymphatic vessel and that is the schliere phenomenon caused by the difference in refractive index between lymphatic fluid and hypertonic glucose solution. This study was approved by the ethics committee of Niigata University (approval number: 2021-0128), and adhered to the tenets of the Declaration of Helsinki.

SURGICAL PROCEDURE

The intraoperative wound with lymphorrhea is observed and filled up with 2–3 ml of 50% dextrose solution. Because the lymphatic fluid is lighter than glucose solution, if the lymphatic fluid exudes from the lymphatic vessel, it is observed rising in the glucose solution like a striped pattern or a misty shadow even though it is the same transparent liquid, just like a point of the ocean where an underwater hot spring is bubbling up, and that is to be the schliere phenomenon caused by the difference in the concentration of lymphatic fluid and hypertonic glucose solution. Once the wound is filled up with 50% dextrose solution, lymphatic fluid usually leaks out of the lymphatic vessel after a little while, as shown in the Supplemental Video, without milking any distal part of the body. If the leakage point is identified, the region is ligated with 6-0 polypropylene sutures (Prolene; Ethicon, Inc., Somerville, N.J.). The wound is closed after confirming that there are no lymph leaks.

CASE REPORT

A 62-year-old man had right inguinal lymphorrhea after an aortic valve replacement. His lymphorrhea started 2 weeks after the surgery; it continued despite conservative treatments, including compression, aspiration, and drainage. Four weeks after the surgery, the wound was subsequently treated with negative pressure wound therapy; every daily amount of lymphorrhea was estimated to be more than 500 ml and showed no signs of decreasing. Eight weeks after cardiovascular surgery, re-exploration...
and macroscopic ligation were performed using the schlieren phenomenon as described (Figs. 2, 3), and the wound was closed in layers. No lymphorrhea recurrence was observed 2 months after the ligation (Fig. 4).

DISCUSSION

When conservative treatment fails for lymphorrhea patients, surgical treatments are usually performed after identifying the site of lymphorrhea using lymphoscintigraphy or ICG.5,6 The best treatment for injured lymph vessels may be direct repair; however, it is difficult to find damaged lymph vessels in a previously treated and scarred wound.8 In addition, lymphatic fluid is colorless and transparent, making intraoperative exact identification of lymphatic leak points difficult. So that treatment often fails, and additional treatments such as lymphaticovenular anastomosis are then often administered.6 To prevent direct repair treatment failure, the exact location of the lymphatic fluid leaking site needs to be identified. For exact identification of lymphatic leak points, ICG is usually used. However, ICG requires an infrared camera system. Those displays are usually placed besides the operation table or on the wall of the operation room. To identify lymphatic vessels in the infrared view, the operator has to move his or her viewpoint from the display to the operation field, back and forth, which means it is difficult to visualize directly in the operative field in real time. There is a report of using digital technology to overcome these shortcomings, but it has not become widespread.7 In addition, ICG adheres to the surgical field, and observation becomes more difficult with time (Fig. 1).

The schlieren phenomenon is a photographic process in which a striped pattern or a misty shadow appears in a transparent medium when the refractive index differs from place to place.

**Takeaways**

**Question:** In patients with lymphorrhea, it is difficult to pinpoint the exact site of lymphatic leakage during surgery. Is there an easy way to do this?

**Findings:** We were able to easily identify the site of the lymphatic leakage in real time by observing the schlieren phenomenon based on the difference in the refractive index between glucose solution and lymph fluid.

**Meaning:** Using glucose solution in the surgical field for lymphorrhea patients is an easy way to identify the exact site of the lymphatic leakage in real time during surgery.
to place. The word *schlieren* comes from the German *schliere*, meaning “streak” in English. For example, a mirage, a naturally-occurring optical phenomenon, is caused by the schlieren phenomena. Because the lymphatic fluid is lighter than glucose solution, in this study, we attempted to identify lymphatic leak points using the schlieren phenomenon caused by the difference in refractive index between lymphatic fluid and hypertonic glucose solution, even though they are the same transparent liquid. With our method using schlieren phenomenon, the only item we need for the surgery is a hypertonic glucose solution. In addition, this method also has the advantage of being able to be used many times intraoperatively because glucose solution does not remain in the surgical field as ICG remains in the surgical field, making observation in the operative field difficult over time. Glucose solution is always available at any facility, and this method seems to be inexpensive and very simple, and no additional system is required. We used this method for a case of lymphorrhea in the groin; it can be used not only in the groin but also in any part of the body where lymphorrhea is observed and where glucose solution can be applied.

Although blood glucose level fluctuation is one of the adverse events to be noted when using 50% dextrose solution, the amount of glucose solution used in the lesion is about 2–3 ml, which is about 1.5 g in terms of dextrose. Even if all of the glucose is absorbed into the body, the blood glucose level fluctuation is considered to be within the range of 10 mg per dL, which has little impact on patients.

**CONCLUSION**

In conclusion, our results indicated that the use of dextrose solution can easily reveal the point where the lymphatic fluid leaks from the lymph vessels under direct vision in the surgical field.

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