OTHERS

Ultrasound-guided muscle dissection for lumboperitoneal shunting via lateral abdominal laparotomy

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Abstract : *Purpose* ; Lumboperitoneal shunting (LPS) is a common procedure for treating idiopathic normal pressure hydrocephalus (iNPH), involving two abdominal approaches : anterior abdominal laparotomy and lateral abdominal laparotomy (LAL). While LAL is advantageous in terms of infection risk, it presents challenges such as muscle manipulation and potential deviation from the desired trajectory. This report presents a novel technique that utilizes ultrasound examination of the lateral abdominal wall (UELAW) to visualize the three muscle layers (external oblique, internal oblique, and transversus abdominis) before abdominal manipulation during LAL. *Illustrative Case* ; An 83-year-old iNPH patient underwent LPS with this approach, ensuring precise alignment of the trajectory and successful access to the abdominal cavity. Following the procedure, the patient experienced an improvement in gait disturbance and was discharged without any surgical complications. *Conclusion* ; The use of UELAW during LPS provides clear visualization of the abdominal muscle layers, allowing surgeons to perform the procedure with confidence and accuracy, minimizing the risk of trajectory deviation, and ultimately improving patient outcomes. J. Med. Invest. 71 : 343-345, August, 2024

Keywords **:** *lumboperitoneal shunting (LPS), ultrasound examination to the lateral abdominal wall (UELAW), lateral abdominal laparotomy (LAL), three muscle layers, trajectory*

INTRODUCTION

Lumboperitoneal shunt (LPS) is a standard procedure performed by neurosurgeons. (1) Some technical devices for LPS concerning operative positioning have been reported, and two different entrances for abdominal manipulation have been reported : anterior abdominal laparotomy (AAL) and lateral abdominal laparotomy (LAL). Some advantages of LAL have been reported : it reduces the risk of infection by not requiring the replacement of drapes because it does not require changing the patient's position ; it prevents the patient from falling off the operating bed because it does not require tilting the operation table ; and it shortens the operative duration compared to AAL (2, 3)

However, some technical problems are often encountered in performing LPS via LAL ; theoretically, the distance from the site of the skin incision (approximately 3-4 fingerbreadths anteroventrally from the midpoint between the supra-inguinal iliac spine and the inferior rib margin) to the abdominal cavity is less than 10 cm, even in obese patients. Therefore, if approached in the direction towards the centre of the trunk from the skin incision site, the abdominal cavity should be reached. However, we often deviate from the planned trajectory relative to the peritoneal layer ; we are particularly prone to deviating in a direction tangential to the abdominal cavity. This deviation not only makes it challenging to reach the abdominal cavity, but also carries the risk of inadvertent entry into the retroperitoneal space.

To overcome this problem and maintain a vertical trajectory towards the abdominal cavity, we determined the direction of abdominal manipulation using ultrasound examination of the lateral abdominal wall (UELAW) to confirm the three layers of the lateral abdominal muscles : the external oblique muscle (EO), internal oblique muscle (IO), and transversus abdominis muscle (TrA). The details of this procedure are presented.

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ILLUSTRATIVE CASE

An 83-year-ole male patient with body mass index 18.37 kg/m^2 experienced gait disturbance and cognitive impairment for six months. LPS was administered using a Codman CERTAS Anti-siphon valve (Integra LifeSciences Corp., USA) because a cerebrospinal fluid tap test showed improvement in his symptoms. After the patient was placed in the lateral position, two surgeons started the procedure simultaneously, one from the back and the other from the ventral side of the patient. (Figure 1A) Before abdominal manipulation, we applied an ultrasound system (LOGIQ e Premium ; GE Healthcare Japan, Tokyo, Japan) with 8C-RS to the abdominal wall. (Figure 1B) Then UELAW clearly showed the three muscle layers ; EO, IO, and TrA (Figure 1C), suggesting a vertical direction through the muscle layer, such that we could easily dissect the muscle layers in the correct direction. After confirming the peritoneum after dissection of these muscle layers (Figure 1D), an incision was made in the peritoneum up to the abdominal cavity (Figure 1E). We inserted a peritoneal tube concatenated with the Codman CERTAS valve at level 6. The patient's postoperative course was uneventful, and we confirmed that the peritoneal tube penetrated the three muscle layers and was placed in the abdominal cavity using abdominal CT obtained 3 days after the procedure (Figure 1F). The patient returned home on the 8th day after the operation with improvement in gait disturbance.

DISCUSSION

Intraoperative US is a useful tool in various procedures and is

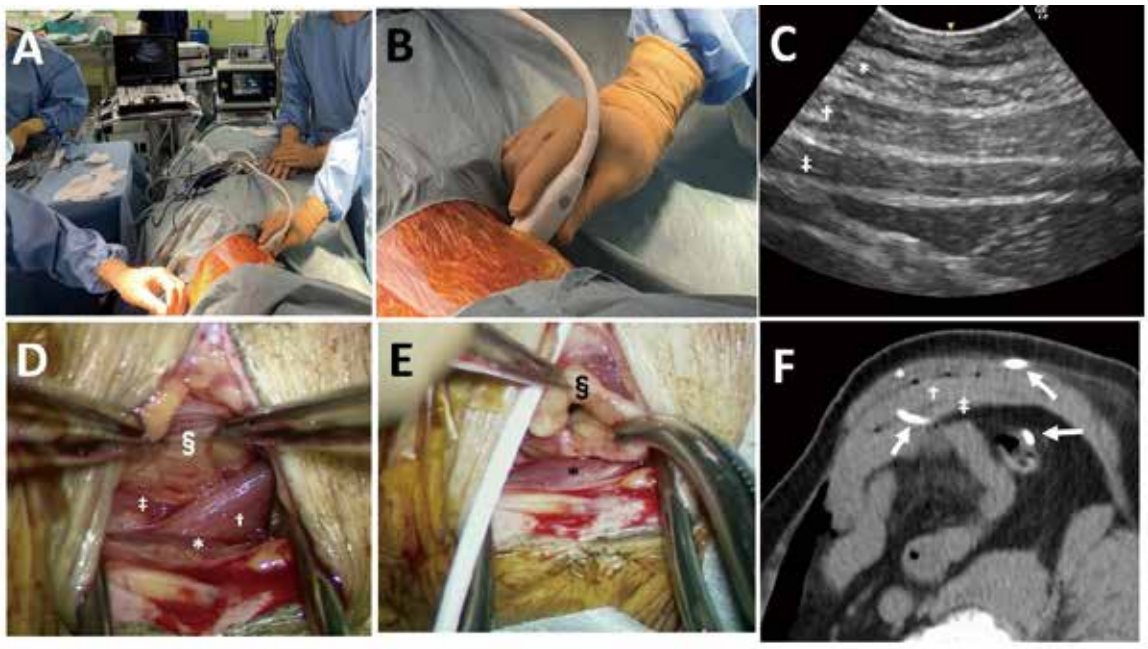

Figure 1.
Illustrative case of lumboperitoneal shunting via lateral abdominal laparotomy in an 83-year-old male patient with idiopathic normal pressure hydrocephalus
Intraoperative photographs showing two surgeons proceeding with the surgery at the same time : one from the back and the other from the ventral side of the patient. (A)
Intraoperative photograph showing the operator applying ultrasound examination to the lateral abdominal wall (UELAW) prior to the abdominal skin incision. (B)
UELAW showing the three muscle layers–the external oblique muscle (asterisk), internal oblique muscle (dagger), and transverse abdominal muscle (double dagger) (C).
Intraoperative photograph showing that the lateral abdominal 3 muscle layers was correctly dissected and the peritoneum (section mark) was confirmed. (D)
Intraoperative photograph showing incision of the peritoneum up to the abdominal cavity (E).
Postoperative abdominal computed tomography performed 3 days after the operation showing that the peritoneal tube (arrows) penetrated the three muscle layers and was placed in the abdominal cavity (F).
* : external oblique muscle, † : internal oblique muscle, ‡ : transverse abdominal muscle, § : peritoneum, arrow : peritoneal tube

likely to be utilised in many neurosurgical departments. However, to the best of our knowledge, no study has demonstrated the usefulness of UELAW for LPS.

Our application of UELAW for LPS has some clinical issues. UELAW can provide a clearer view of the three lateral abdominal muscles that guide in the correct direction to the abdominal cavity. To date, UELAW has been employed for several purposes, including assessment of respiratory function (4, 5), diagnosis of muscle disorders (6) or diseases of the abdominal wall, such as abdominal muscle abscess (7, 8), and evaluation of rehabilitation exercises (9). To the best of our knowledge, this is the first report demonstrating the usefulness of UELAW in LPS treatment.

The three muscle layers can be prevented from separating by dissecting vertically through the abdominal wall, following UELAW instructions. Anatomically, the three muscle layers (EO, IO, and TrA) that make up the lateral abdominal wall do not have a tough fascia and can be easily separated by blunt dissection. If the three muscle layers are separated, we tend to proceed in a direction tangential to the abdominal cavity, which deepens the operative field and makes it difficult to proceed to the abdominal cavity.

The limitation of UELAW is that it cannot clearly visualize other structures such as the abdominal cavity and retroperitoneal space, even though this information would be useful for determining a more accurate trajectory. This limitation arises from the fact that a single ultrasound probe cannot effectively visualize all structures from the abdominal wall to the abdominal cavity and/or retroperitoneal space. This limitation stems from the differing capabilities of ultrasound probes : those designed for superficial areas cannot effectively visualize deep tissues, and vice versa. For instance, the 8C-RS probe used in our procedure, with a frequency of 8 megahertz (MHz) and designed for superficial use, can only investigate to a depth of 5 cm or less. While it excels at depicting the three muscle layers of the abdominal wall, it struggles to visualize the abdominal cavity or the fat within the retroperitoneal space. Conversely, probes targeting deep tissues, such as those used for abdominal examinations, face challenges in clearly visualizing the three muscle layers of the abdominal wall simultaneously with structures in deep areas.

The difficulty in visualizing deep structures is also compounded by the nature of ultrasound itself. Anatomically, the retroperitoneal space, located dorsally in the abdominal cavity, is challenging to visualize due to the attenuation of ultrasound waves by gas or stool when performing ultrasound examinations from the anterior or lateral sides of the abdominal wall. Consequently, it becomes difficult to visualize the fat in the retroperitoneal space when exploring from the skin incision site

of the LAL that we employ. Given these limitations, we deem it realistic to restrict intraoperative ultrasound examination, which requires simplicity, to confirming the three muscle layers of the abdominal wall.

In conclusion, UELAW maintains a vertical trajectory towards the three muscle layers and the abdominal cavity, which is crucial to avoid potential pitfalls or complications.

CONCLUSION

When LPS is performed via LAL, UELAW during abdominal manipulation can reveal the correct trajectory of the abdominal cavity.

CONFLICT OF INTEREST

The authors report there are no competing interests to declare.

The authors have no relevant financial or nonfinancial interests to disclose.

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Ethical approval and consent to participate : All procedures in this study were performed in accordance with the 1964 Declaration of Helsinki. A series of treatments were performed after obtaining appropriate written informed consent from the patients. The requirement for additional written consent for inclusion in this study was waived by the Ethics Committee of Saiseikai Shiga Hospital because of the retrospective and observational nature of the study.

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