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Invention of Two Instruments Fitted with SECUREA™ Useful for Laparoscopic Liver Resection

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Laparoscopic liver resection (LLR) became common in Japan when advanced techniques and instruments for the procedure became available and the national medical insurance began covering partial resection and lateral segmentectomy. A successful LLR requires a gentle and powerful hold on the specimens, a steady operating field, and fast and rapid compression of the bleeding point to achieve hemostasis. In this paper we describe two instruments developed in our department by attaching the SECUREA™ endoscopic surgical spacer to the forceps and suction tube used for LLR. The instruments are useful and practical for any type of LLR, even in the hands of less experienced surgeons.
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Key words: laparoscopic, liver resection, new instrument, SECUREA

Introduction

Laparoscopic liver resection (LLR) became a common procedure in Japan when advanced techniques and instruments became available and the national medical insurance began covering partial resection and lateral segmentectomy. A successful LLR requires gentle and powerful hold of the liver parenchyma, a steady operation field, and fast and rapid compression of the point of bleeding to achieve hemostasis.

The SECUREA™ endoscopic surgical spacer is made of a polyurethane sponge we developed with Hogy Medical Co., Ltd. (Tokyo, Japan). This spacer is advantageous for safely because it gently holds intra-abdominal organs and tissues with forceps, prevents the spread and facilitates the removal of exudate, and prevents secondary injuries caused by surgical instruments. The SECUREA™ can also be easily prepared for use with scissors or a surgical knife[1].

In this paper we describe two useful and practical instruments developed in our department by attaching SECUREA™ to the forceps and suction tube used for LLR.

Preparation of the Two Instruments

A. Preparation of the Laparoscopic Forceps by Attaching SECUREA™ (Fig. 1a)

1. Cut the SECUREA™ radiopaque marker.

2. Cut SECUREA™ into two small pieces along the sagittal plane (the small size of SECUREA™ is provided as an elliptical cylinder measuring 4.0 cm on the major axis, 2.5 cm on the minor axis, and 1.5 cm in height) (**Fig. 1b**).

3. Make a longitudinal slit at the bottom center of each piece using a No. 15 surgical knife (**Fig. 1c**).

4. Insert each tip of the straight laparoscopic forceps (with a hole) into the slit up to the root.

5. Fix the forceps and a piece of SECUREA™ with thread using a needle at the closing of the root (**Fig. 1d**).

B. Preparation of the Laparoscopic Suction Tube with SECUREA™ (Fig. 2a)

1. Cut the SECUREA™ radiopaque marker.

2. Cut off both sides of the small SECUREA™ along the sagittal plane. The length of remaining piece should be half of the length of the short axis (**Fig. 2b**).

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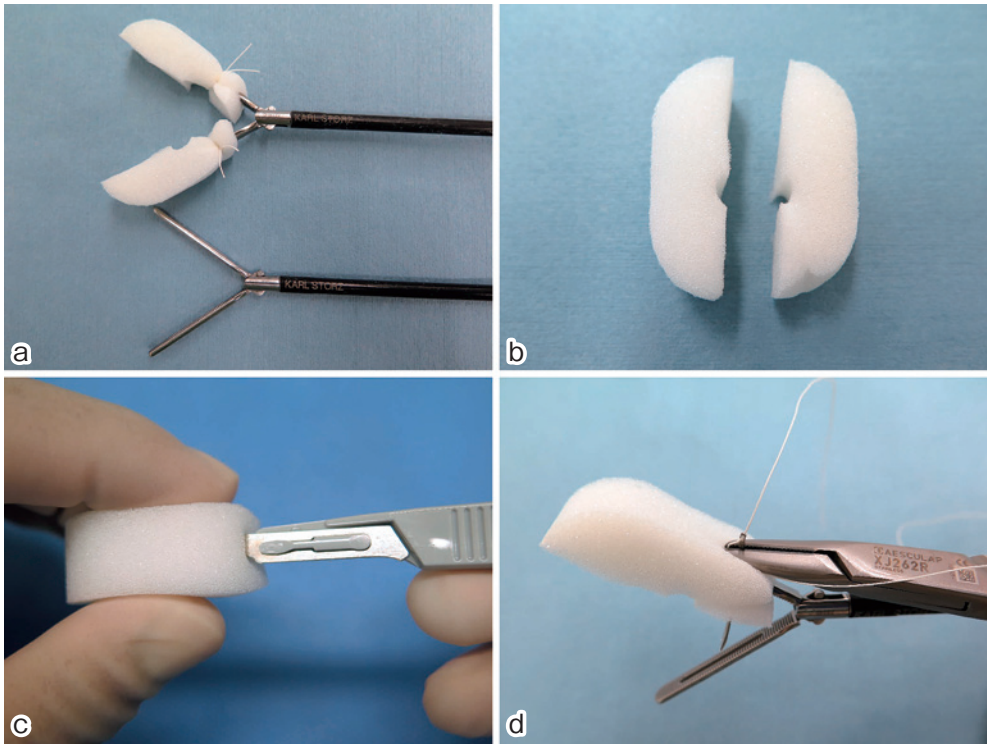

Fig. 1 **a**. A panoramic view of the laparoscopic forceps with SECUREA™.
Above is the laparoscopic forceps with SECUREA™, and below is the straight laparoscopic forceps (with a hole) before SECUREA™ is attached.
b. The small size of SECUREA™ cut into two small pieces along with the sagittal plane.
c. A longitudinal slit being made at the bottom center of each piece with a No. 15 surgical knife.
d. The forceps and a piece of SECUREA™ are fixed with thread using a needle at the closing of the root.

3. Make a longitudinal slit at the bottom of the center of the middle pieces to be penetrated using the No. 15 surgical knife from the other side of the hole for the radiopaque marker.

4. Insert the tip of the laparoscopic suction tube into the slit up to the hole (**Fig. 2c**).

5. Securely tie the suction tube and the SECUREA™ with a 3-0 thread twice at the closing of the bottom of the SECUREA™ (**Fig. 2d**).

Actual Use

A. Laparoscopic Forceps with SECUREA™

The laparoscopic forceps with SECUREA™ can be inserted via a 12-mm-diameter port and can be advantageously performed with the following maneuvers.

1. Gently and safely hold intra-abdominal organs and tissue (**Fig. 3a and b**)

The forceps can be used for closing and opening the tips of the forceps. Both uses allow the gentle and safe holding of intra-abdominal organs and tissue (**Fig. 3a**)[1]. When the forceps are being opened, the specimen can be hooked between the tips to enable steady and strong holding (**Fig. 3b**). The direction in which the specimen is held can be difficult to change when the tips of the forceps are closed. With the tips open, the stronger fixation to the specimen versus the closed-tips method makes the direction easier to change.

2. Grasping organs atraumatically (**Fig. 4a and b**)

The forceps can grasp organs atraumatically because the attached SECUREA™ is made of soft polyurethane sponge. When, for example, the forceps grasp the gallbladder and move it freely during the operation, the gallbladder is trackless even after the manipulation. Although the intestinal tract and greater omentum are easily injured when grasped by ordinary laparoscopic forceps, they can be grasped atraumatically with SECUREA™ forceps. The specimen can also be grasped and pulled. A useful approach in laparoscopic liver resection is to prepare the resection plane and then grasp the liver with these forceps and push and pull.

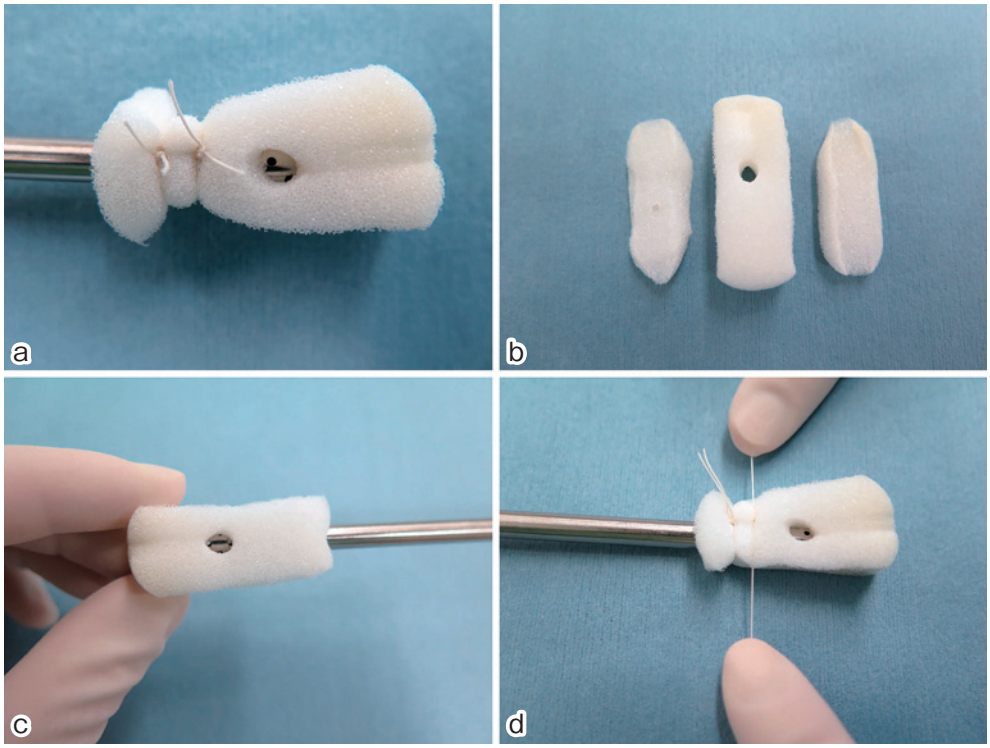

Fig. 2 **a**. A panoramic view of the laparoscopic suction tube with SECUREA™.
b. The small SECUREA™ is cut off along both its sides along the sagittal plane. The length of the remaining piece should be half of the length of the short axis.
c. The tip of the laparoscopic suction tube is inserted through the slit to the hole.
d. The suction tube and SECUREA™ are securely tied twice with 3-0 thread at the closing of the bottom of the SECUREA™.

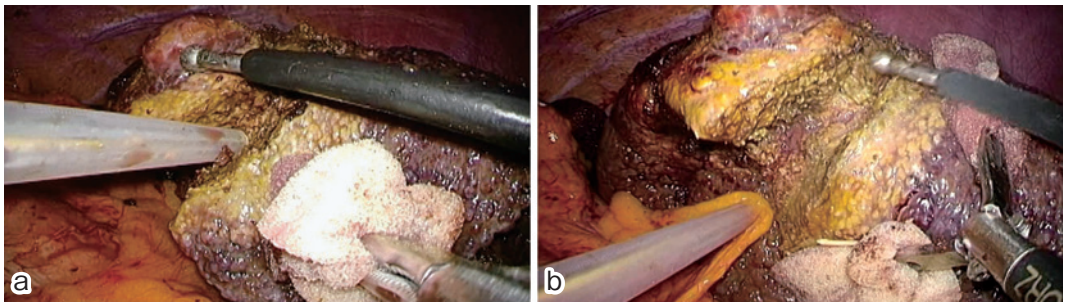

Fig. 3 **a**. The laparoscopic forceps with SECUREA™ can be used to close the tip and gently and safely hold the intra-abdominal organs and the tissue.
b. When the forceps are opened, the specimen can be hooked between the tips to enable a strong and steady hold.

3. Quick and easy astriction

Astriction is the most primitive hemostasis method in both open and laparoscopic liver resections. Laparoscopic forceps with SECUREA™ can be used to quickly and easily achieve compressive hemostasis. Because we usually use this instrument during liver resection to keep the resection plane, we can quickly compress a bleeding point using the tips even when the bleeding is suddenly encountered. Furthermore, SECUREA™ can stop bleeding by suppressing a bleeding point from the resected liver parenchyma and the comparatively large hepatic vein. When the bleeding point has been compressed we can clean the operation field around it and calmly prepare other secure methods to achieve complete hemostasis (e.g., with hemostasis instruments and suturing). Next, we can easily detach the instrument from the bleeding point because the sponge material is less adhesive than gauze and is unlikely to adhere to the tissue

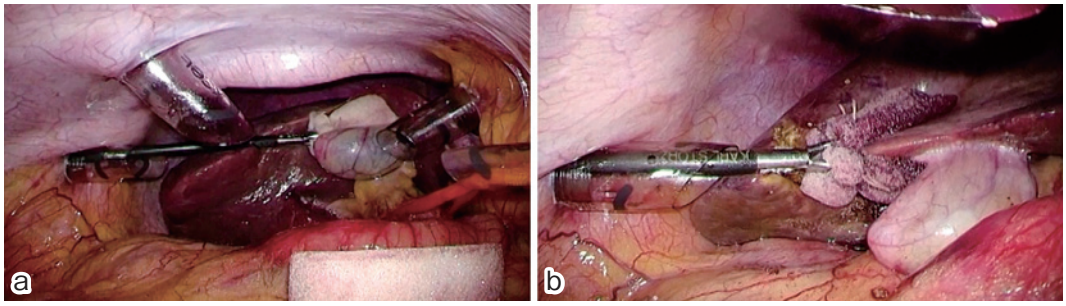

Fig. 4 **a**. The laparoscopic forceps with SECUREA™ can grasp the gallbladder gently and move it freely during the operation.
b. Even after the manipulation, the gallbladder is trackless.

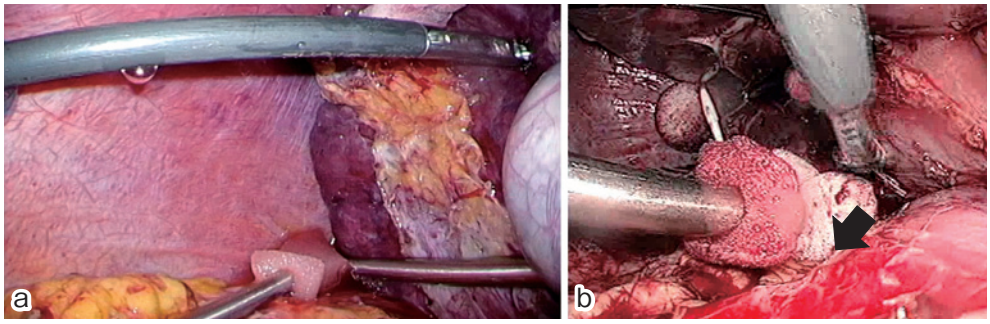

Fig. 5 **a**. The laparoscopic suction tube with SECUREA™ can aspirate the exudate without being trapped because the effusion can be drained through the sponge and the aspiration tube does not come into contact with tissues.
b. The bleeding point from the right adrenal gland (**arrow**) is immediately compressed by the laparoscopic suction tube with SECUREA™.

and cause additional injury. Ultimately, we can calmly achieve total hemostasis in a stable operation field.

B. Laparoscopic Suction Tube with SECUREA™

The laparoscopic suction tube with SECUREA™ can be inserted via a 12-mm-diameter port and be used to advantageously perform several maneuvers.

1. Aspiration of the exudate without becoming trapped

The suction tube can aspirate the exudate without becoming trapped. The effusion can be drained through the sponge; hence, the aspiration tube remains clear of the tissues and the amount of pneumoperitoneum gas aspirated in the abdominal cavity is decreased. The exudate absorbed by the sponge material can also be aspirated, restoring the SECUREA™ to its original state (**Fig. 5a**).

2. Quick and easy astriction

In our surgical theatre, the first assistant surgeon usually uses this instrument while resecting the liver to clear the resection plane with a suction tube, spray with water, and maintain the plane. We can therefore compress the bleeding point immediately, just as we can with the laparoscopic forceps fitted with SECUREA™. The suction tube can also aspirate blood and immediately clean the operating field around the point (**Fig. 5b**).

Discussion

SECUREA™ is an endoscopic surgical spacer made of polyurethane sponge usable with a radiopaque marker. Our group developed it as a commercial product in collaboration with Hogy Medical Co., Ltd. Earlier reports have described the usefulness of SECUREA™ for laparoscopic procedures[1,2]. The product was originally developed to permit the use of forceps to safely hold organs and tissues from the surgical field, to prevent the spread and facilitate the removal of exudate, and to prevent secondary injuries caused by surgical instruments. In addition, SECUREA™ can be easily prepared for use with scissors or surgical knives, and once prepared the cut surfaces never shred. This simple workability allows SECUREA™ to be fixed onto forceps and suction tube without its safety being concerned.

Since the first LLR reported in 1993, remarkable achievements in this field in many countries have allowed pure laparoscopic major hepatectomy and donor hepatectomy to be performed for living donor liver transplantation[3–8]. Laparoscopic hepatectomy is theoretically superior to open hepatectomy by offering better visibility of the operative field because of the magnifying effect and reduced hemorrhage from the hepatic vein due to pneumoperitoneum pressure. In addition, LLR has been reported to be superior to the open method because of the lower volume of intraoperative bleeding, fewer postoperative complications, and shorter postoperative hospital stay[5]. For reasons such as these, the laparoscopic approach for liver resection is expected to be adapted for partial hepatectomy, left lateral sectionectomy, anatomical subsegmentectomy, major hepatectomy, and donor hepatectomy by many institutions throughout the world.

In North America and Europe, LLR is most often performed at academic medical centers. In contrast, in Japan LLR has most often been performed by surgeons affiliated with community hospitals and accounts for up to 40% of all liver resections documented[9]. Hence, LLR is performed in Japan by surgeons with all levels of experience, from very little to a great deal. The development of instruments well suited to LLR would ensure steady and safe procedures for the less experienced surgeons and could possibly contribute to the standardization of the procedure. On the other hand, the "move the ground" technique to reposition the manipulating organs to where surgical procedures can easily be performed, which is especially called for in laparoscopic surgery for intestinal tracts, may be difficult to use when an organ has anatomical features similar to those of the liver: many vessels, a substantial weight of 1.0 to 1.5 kg, and many ligaments attached to its surface. The LLR procedure is also more difficult than an open hepatectomy, as movement restrictions are imposed upon a surgeon operating from outside a body cavity via implanted ports. The instrument used to perform LLR should be capable of holding specimens both gently and powerfully through successive pushing and pulling maneuvers. The instrument should also be capable of maintaining a stable operating field and quickly achieving hemostasis by compressing a bleeding point promptly and accurately.

A greater percentage of metastatic liver cancers are being resected, but many patients have liver damage because of previous chemotherapy[10]. The incidence of hepatocellular carcinoma from the nonalcoholic steatohepatitis liver is increasing both in Japan[11] and the rest of the world[12]. These livers have fragile capsules and soft parenchyma and easily bleed. With these livers, our new forceps and suction tube might be useful both in dividing the ligaments around the organ and in resecting the parenchyma. Meanwhile, gentler maneuvers are required in living donor hepatectomy, as damage to the liver parenchyma must be minimized in both the resected and remnant liver. Our new device may also be useful for that type of procedure.

The improvement and development of instruments for LLR by surgeons collaborating with the medical industry can have great benefits. Our group has now developed and commercialized instruments of this type in collaboration with Hogy Medical Co., Ltd.

We perceive the safety to use our new devices could be secured because it is permitted the manufactured such commercial device during the operations can use by surgeon's discretion in the medical practitioners' low if the device is thought to be useful. However, we have to thoroughly confirm the items after the use without the defect and the remaining.

We believe that these instruments will expand both the indications and adaptations for LLR and will improve the outcomes of the procedure, regardless of the surgical experience of the surgeon.

Conclusion

We believe our newly invented forceps and suction tube mounted with specially prepared SECUREA™ will be proven to be practical, useful, and ideal instruments for any kind of LLR, even in the hands of less experienced surgeons.

Conflict of Interest: The authors declare no conflict of interest.

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