Progress in endoscopic ablation for hepatocellular carcinoma

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Abstract

In recent years endoscopic surgery has spread worldwide and has been performed widely in the field of liver surgery. Endoscopic surgery for hepatocellular carcinoma (HCC) was adopted in our department in 1994. On the other hand, local ablation therapy has also become established as one of the effective therapies for HCC. However, there is a limit for percutaneous ablation, and overdoing can cause. Endoscopic ablation is used to relieve this condition. Indication for ablation therapy has spread through the increasingly precise use of thoracoscopes and laparoscopes. Furthermore, further ingenuities of endoscopic technique will widen the range of indication as well as improve safety and certainty of ablation therapy.

We encourage a wider application of ablation therapy for use as a treatment strategy for HCC.

Key words: endoscopic surgery, hepatocellular carcinoma, radio-frequency ablation

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Introduction

Recently, various endoscopic surgeries have been enabled through developments in medical equipment and improvements in surgical techniques. In the field of liver surgery, endoscopic hepatectomy, endoscopic deroofing or fenestrations for the liver cysts and endoscopic ablation have come to be accepted applications of endoscopic surgery. Endoscopic ablation, using microwave coagulation therapy (MCT) or radiofrequency ablation (RFA), was developed in our department in 1994. Percutaneous, endoscopic and open approaches for local ablation therapy are selected according to tumor location, size and number. Endoscopic ablation is especially useful for superficial HCCs in order to avoid neoplastic seeding. In this article, we summarize the standard procedure for thoracoscopic and laparoscopic ablation and introduce some innovations to achieve safer and more effective ablation.

Indications for endoscopic ablation

Endoscopic ablation was applied in the treatment of essentially unresectable patients with poor hepatic reserve. Basically, superficial HCCs, up to 3 nodules each smaller than 4 cm and without vascular invasion, are good candidates for endoscopic ablation. Ablation may be selected for the treatment of tumors: with a difficult visualization by diagnostic imaging, with impossibility to access percutaneously, and bordering on organs such as gastrointestinal tract, gallbladder, diaphragm and others. Contraindications for endoscopic ablation include irreversible liver cirrhosis (uncontrollable ascites and hyperbilirubinemia >3 mg/dL) and patients with possible severe adhesion after poly-surgery or abdominal trauma.

Standard procedures of thoracoscopic ablation

Step1: Placement of trocar and observation of thoracic cavity Under general anesthesia with 1 lung ventilation, the patient is placed in a modified left lateral decubitus position (Fig. 1A). An approximately 15 mm incision is made on the anterior axillary line of the right 4-6th inter-costal space. The first 12 mm trocar is inserted under direct vision. The camera is inserted through the port to observe the thoracic cavity (Fig. 1B). The locations of other trocars are determined by considering anatomic configuration.

Step2: Detection of HCCs by ultrasonography A linear type 10 mm, 7 MHz ultrasonography probe is commonly used. The probe can be pushed into a diaphragm directly and used in the detection of all intrahepatic lesions through a diaphragm. A convex probe (forward-viewing convex-array transducer) (Toshiba Corporation, Tokyo, Japan) is useful for targeting the HCC. An approximately 20 mm incision is necessary for flexible use of the probe. When this incision is performed directly on top of the tumor, the capturing and puncture of the tumor will be facilitated. This osculum for inserting the probe should be facilitated using a non-rib spreading method and covered by a Lapprotector (Hakko Shoji Co. Ltd., Tokyo, Japan)(Fig. 1B). Through this osculum various intra-thoracic procedures, including the incision of some adhesion or fibrous tissue by monopolar cautery and manual pulmonary exclusion are enabled.

Step3: Tumor puncture and ablation using guide by ultrasonography When performing the puncture with a forward viewing convex probe (Fig. 1C), the procedure is comparatively facilitated. We can confirm the position of the needle in real time on the screen. If the tumor cannot be detected clearly by normal ultrasonography, the contrast media, such as Sonazoid(GE Healthcare, Oslo, Norway), will be used. The contrast-enhanced ultrasonography requires an exclusive ultrasound system and probe. Incision of the diaphragm is available for direct observation of superficial tumors (Fig. 1D). In tumors with extrahepatic growth, puncture directly to the tumor through a diaphragm should be avoided in order to prevent neoplastic implantation. In such cases, marginal pre-ablation method must be performed while confirming the tumor directly after incision of a diaphragm. The incision should be performed with laparoscopic coagulating shears (LCS, Ethicon Endosurgery Inc., Cincinnati, Ohio) (Fig. 1D) or a Bi-Clamp (ERBE, Tubingen, Germany). After the ablation of the target lesion, suturing with non-absorbable threads should be performed to the opened diaphragm. A 12 Fr thoracic catheter is then placed into the thoracic cavity until the following morning.
Standard procedures of laparoscopic ablation

Step 1: Placement of trocar and observation of liver and abdominal cavity
Under general anesthesia, the majority of patients are placed in a spine position. The procedure is performed using 2 or 3 trocars in the upper abdomen. A 12 mm trocar is introduced under direct vision through an umbilical incision. In patients with portal hypertension the paraumbilical vein may expand. Therefore, it is important that an upper median incision be avoided, and it is recommended that an incision be performed on the umbilical right or left side. The camera is inserted through the port, and the abdominal cavity and liver surface are observed extensively. When a tumor is present on the surface of the hepatic reverse side, hepatic elevation and the exclusion of the circumference organ are necessary through use of equipment.

Step 2: Detection of HCCs by ultrasonography
A linear probe is useful for searching out tumors in deeper areas of the liver. Even if there is a tumor on the surface of the liver, an examination by ultrasonography is important. Tumor size, tumor number and the anatomical positional relationship between the tumor and the surrounding vessels should be observed thoroughly, sometimes using Doppler imaging. Sufficient examination before puncture may prevent complications such as biliary injury. When using a forward viewing convex probe, 1 suitable wound for port must be widened by adding

Figure 1 Thoracoscopic ablation
A: Under general anesthesia, the patient is placed in a modified left lateral decubitus position.
B: dark allow: A thoracoscope was inserted through the first 12 mm trocar, white allow: A forward-viewing convex probe and a Cool-tip™ needle were inserted through the newly incised osculum covered by Lapprotector™.
C: A Cool-tip™ needle is used for ablation along the ditch of the forward-viewing probe side.
D: Incision of the diaphragm is performed with LCS.
an incision and attaching a kind of plastic port, such as a Lapdisk® (Hakko Shoji Co. Ltd., Tokyo, Japan), without loss of pneumoperitoneum.

Step3: Tumor puncture and ablation using guide by ultrasonography  Marginal pre-ablation methods can prevent a more than required elevation of intra-tumoral pressure caused by ablation of superficial tumors. In this method, ablation must be started from the surrounding liver parenchyma. Using a 20 mm length Cool-tip™ (Valleylab, Boulder, Colorado) needle, a complete ablation of tumors smaller than 25 mm in diameter is possible with multiple punctures of the surrounding liver parenchyma. After enough ablation has been performed, the tumor on the liver surface experiences turgescence through moderate elevation of intra-tumoral pressure, and the color changes to white. Such changes can be confirmed endoscopically (Fig.2 A-D).

Ingenuities of endoscopic ablation

However, endoscopic ablation for all HCCs using the above method is not possible. Various ingenuities to widen the indication of endoscopic ablation will be introduced briefly.

1. Hybrid ablation method

Puncture of the tumors in deeper sites of the liver using a linear probe is relatively difficult. If the confirmation of

Figure 2  Laparoscopic ablation using a linear probe
A: When an enough saline is used as artificial ascites, an image by the ultrasonography becomes clear.
B: Puncturing is performed while keeping distance from other organs by lifting the liver and confirming with ultrasonography.
C: Ablation is started from liver parenchyma around a tumor existing top of the liver with lifting the diaphragm.
D: After enough ablation was performed, the tumor does turgescence by elevation of intra-tumoral pressure, and a color of tumor surface turns whitish.
the presence of a tumor is possible with a linear probe, it is difficult to see a puncture needle tip in real time. A forward viewing convex probe is useful in such a case. When there are tumors both on the surface and in deeper sites of the liver at the same time, ingenuity is required. Therefore, we have developed a method using an endoscopic approach together with a percutaneous approach. When an endoscopic approach is taken earlier, remnant air bubles might interface with percutaneous ultrasonographic detection. However, the problem may be resolved by injecting saline to act as artificial ascites (Fig. 3A). Use of artificial ascites elevates the detection sensitivity of the tumor, and percutaneous puncture can be facilitated (Fig. 3B). Pneumoperitoneum is performed once again after percutaneous ablation. Endoscopic observation of the intrabdominal cavity is necessary to confirm that no hemorrhage from puncture sites has occurred, that there are no iatrogenic injuries to other organs.

2. Hand-assisted endoscopic ablation

Hand-assisted ablation is applied for patients in high difficulty bowel. Hand-assisted method is performed with the aid of a plastic hand port (Fig. 3C), such as a Lapdisk®, which consists of a sealed cuff that enables a hand to be inserted into and withdrawn from the abdomen without loss of pneumoperitoneum during the procedure (Fig. 3D). By using the hand-assisted method, development of working space and exclusion of the surrounding organs make the puncture quite safe and precise. Recommended location of the horizontal incision for hand-assisted method is on the right sub-costal and umbilical area (Fig. 3E).

3. Preoperative trans-arterial chemoembolization (TACE)

Preoperative TACE with lipiodolization is used as an adjuvant therapy in some HCC patients to make endoscopic ablation more effective and to detect tumors clearly. TACE, which is one of the main therapies for HCC7, can reduce the tumor size in order to enable ablation. Furthermore, targeted tumor and coagulative areas are clearly visualized as high-density areas with non-enhanced low-density areas by enhanced CT (Fig. 3F).

4. Intercostal tumor puncture in laparoscopic ablation

When a tumor is located in cranial parts of the liver, intercostal puncture is recommended (Fig. 3G). To avoid pulmonary injury, the caudal edge of the lung must be checked before ablation using ultrasonography from the body surface (Fig. 3H). This procedure is possible through use of a linear probe. A chest X-ray must be done after ablation by puncturing through the intercostal space. The insertion of the thoracic cavity drain is necessary if pneumothorax is confirmed.

Conclusions

Endoscopic ablation can expand the indication of the ablation while maximizing safety. This therapeutic modality is positively encouraged for wider application as a treatment strategy for HCC.

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References

Figure 3  Ingenuities of endoscopic ablation
A: Enough saline injection into the abdominal cavity as a artificial ascites.
B: Percutaneous puncturing guided by ultrasonography.
C: A Lapdisk® is attached to an incised hole on the right sub-costal area.
D: An operator's hand is inserted into the abdominal cavity through the Lapdisk®.
E: Grasping a part of the liver and fix it for ablation.
F: A high-density area is lipiodolized part which means the place of real tumor marked by preoperative TACE and a low-density area is ablated part of the liver in post-ablation plain CT.
G: The artificial ascites are useful in laparoscopic ablation.
H: The position of the pulmonary bottom end is marked with using ultrasonography and ablation is achievement through intercostals space.