Symposium 1

Liver Resection Using Advanced Tools

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The risk of massive bleeding and the complicated biliary and vascular anatomy has been challenging problems of liver resection. "Bloodless" liver surgery has a relatively short history. While the operative mortality rate of liver resections was beyond 20% and mainly related to massive hemorrhage until the 1980s, it has decreased to less than 5% in current specialized centers. The improvement of perioperative outcomes is due to a better understanding of the liver anatomy, advances in anesthesia techniques, better perioperative management and innovations in specific instruments for liver resection.

Finger fracture or clamp crushing is a conventional technique for transection of liver parenchyma. Over the past 20 years, the specific instruments for liver transection have been developed such as the ultrasonic dissector, water jet, ultrasonic shear, Ligasure, TissueLink dissecting sealer and radiofrequency-assisted liver transection. In this session, the current techniques and instruments for liver transection will be introduced and compared on the efficacy of different techniques.

Techniques of Liver Transection

1. Finger fracture/Clamp crushing

Lin et al first introduced the finger fracture techniques in 1958, which involves crushing of liver parenchyma by fingers under inflow occlusion to isolate vessels and bile ducts. This technique was subsequently improved through the introduction of other instruments such as the Kelly clamp. Currently the clamp crushing technique is a low-cost technique and one of the most widely used techniques. However, it requires substantial experience to be used effectively for liver transection, especially in the cirrhotic liver.

2. Ultrasonic dissection

An ultrasonic dissector using Cavitron Ultrasonic Surgical Aspirator (CUSA, Integra Radionics, USA) is commonly used for liver transection in many centers. Ultrasonic energy, which generates at the tip of the handpiece, fragments the liver parenchymal tissue and the simultaneous function of irrigation and aspiration clearly exposes vessels and bile ducts, which can be clipped and ligated. CUSA can be effectively used in both cirrhotic and non-cirrhotic liver, and it is the current standard liver transection technique in many centers.

3. Water jet

The kinetic energy of a pressurized water jet fragments the liver parenchymal tissue and exposes the hepatic vein and portal pedicles. The recent water jet dissector (ERBEJET, GmbH, Germany) is equipped with monopolar electrode and suction function. With sharp dissection of a water jet, there is no thermal or unintentional mechanical damage at the resection margin. Therefore, the water jet technique is quiet good for dissecting out major hepatic veins. One disadvantage in liver resection is the long transection time because even small portal pedicles exposed by a water jet should be ligated or clipped. This technique is not as popular as CUSA.

4. Ultrasonic shear

Ultrasonic shear (Harmonic Scalpel, Ethicon Endo-Surgery, USA) has sealing and tissue-cutting effects at the same time. The blade's longitudinal vibration with a frequency of 55.5 kHz can transect liver parenchyma effectively due to the saw mechanism in the direction of the vibrating blade. The coagulation effect is caused by protein denaturation (coagulum), which

occurs as a result of destruction of the hydrogen bonds in proteins and generation of heat in the vibrating blade. Blood vessels up to 2~3 mm are coagulated on contact with the vibrating blade. The New Harmonic ACE can seal effectively up to 5 mm vessel due to the quickly driving up of the instrument temperature.

This instrument has been used for liver transection. One concern is that Harmonic Scalpel may not be effective in sealing bile ducts. Because Harmonic Scalpel can not sufficiently seal large vessels and can injure them, it has a limitation in dissecting the liver parenchyma either around the major portal pedicles or around the main trunk of hepatic veins. This instrument can be useful in combination with the use of ultrasonic dissection or water jet and is commonly used in laparoscopic liver resection.

5. Ligasure

While Harmonic Scalpel uses ultrasonic energy, Ligaure uses an electric energy to seal small vessels. The combination of electric energy and compression pressure causes shrinkage of collagen and elastin in the vessel wall. This instrument has improved sealing effect on vessels up to 7 mm in diameter. However, there is also some concern as to the sealing capacity in large bile ducts. In recent randomized study, the use of Ligasure in combination with a clamp crushing technique reduced blood loss and transection time compared with the conventional technique. Similar to the Harmonic Scalpel, laparoscopic Ligasure is a useful instrument for laparoscopic resection of peripheral liver lesions.

6. TissueLink dissecting sealer

A new technology using saline-linked RF energy (TissueLink Medical, USA) has been developed for liver transection. Saline runs to the tip of electrode to couple RF energy. This mechanism allows transection and sealing of vessels simultaneously during parenchymal transection. The reports for liver transection are preliminary and should be evaluated in the further studies.

7. Radiofrequency-assisted liver transection

Radiofrequency (RF) ablation is a good technique for the treatment of liver tumors. A new technique of liver transection using RF thermocoagulation has been described recently. With this technique, a Cool-tip RF electrode in inserted in the transection plane serially every 1~2 cm, applying energy for 1~2 minutes, to create coagulated cylinders, that then can be cut by a scalpel.

The advantage of this technique is its simplicity, when compared to the other techniques. One of the potential disadvantages is the sacrifice of liver parenchyma that is coagulated, leaving up to 1 cm of necrotic tissue, which can be critical in cirrhotic patients. There exists the concern for damage to the hilar structures and hepatic veins. The use of this instrument should be further evaluated.

Comparison of Different Liver Transection Techniques

Two recent meta-analysis of randomized controlled trials of different liver transection techniques concluded that clamp crushing techniques was more rapid and decreased blood loss and otherwise similar outcomes compared with other liver transection techniques such as CUSA, the water jet and the radiofrequency dissection sealer. However, the result with each transection technique is significantly affected by the individual surgeon's experience with the respective technique. The clamp crushing techniques requires longer learning curve compared to other techniques. Therefore, well-designed randomized trial should be performed to compare different techniques in deleting the surgeon's bias.

Conclusions

While the choice of liver transection technique is often based on the individual surgeon's preference, the clamp crushing and ultrasonic dissection have been widely used. CUSA and water jet dissection can be a good option for the liver resection, which requires clear dissection of the hepatic vein.

Newer instruments such as the Harmonic Scalpel, Ligasure and TissueLink dissector enhance the capability of hemostasis and allow faster transection. However, they lack the safety in dissection of major hepatic veins and they may be associated with increased risk of bile leakage. When used alone, they are suitable for limited liver resection of superficial or peripheral liver tumors, and they are particularly useful in laparoscopic liver resection. They can also used in combination with CUSA or water jet for sealing vessels, but this can increase the cost substantially. The cost of these instruments should play a part in the

surgeon's decision as to whether to use them or not. Therefore, the cost-effectiveness of these new instruments should be also evaluated in further studies.

References

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