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Modified extracorporeal traction with wires: a method for steering the liver for laparoscopic resection of hepatic tumors in segment 7 (with video)

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Abstract

Background Laparoscopic hepatectomy is a less traumatic, minimally invasive procedure that has been widely used to address liver tumors because of its association with a faster recovery and less bleeding. Although adequate exposure and transposition of the liver ensure a clear surgical field and a successful operation, tumors in S7 present a challenge in that surgeons experience difficulty in exposing such tumors and the operating space is small. We used a modified extracorporeal traction with wires method for use in minimally invasive hepatic resection surgery to improve visibility of the surgical field and therefore reduce the difficulty of surgery. The method involved adjusting the traction force appropriately for transposition of the liver.

Methods We reviewed data from 15 laparoscopic hepatic tumor resections performed between January and November 2024. In this paper, we describe the surgical and traction techniques used and evaluate the intraoperative and postoperative course.

Results The study population consisted of 9 males and 6 females, and the median mean age was 61.84 ± 11.08 years (Table 1). The median body mass index was 25.65 ± 3.14 kg/m2, the median tumor size was 3.78 ± 2.09 cm, the median operative time was 154.09 ± 31.97 min, the median intraoperative blood loss volume was 115.36 ± 51.26 ml, and the median hospitalization time was 10.33 ± 2.09 days.No serious intraoperative or postoperative complications occurred, and R0 resection was achieved in all cases. Morevoer, in all cases, the time to set up bandwire extracorporeal traction was less than 3 min.

Conclusion The bandwire traction technique can provide a more stable surgical field, shorten the surgical time, and reduce the likelihood of surgical trauma. The technique allows safe transposition of the liver and plays an important role in minimally invasive resection of hepatic tumors, highlighting its suitability for widespread clinical applications.

Keywords Liver steering technology, Laparoscopic resection, Tumor of the S7 segment, Liver traction

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Introduction

Laparoscopic hepatectomy has become the most widely used standard procedure for treating hepatic malignancies [1]. Compared with conventional open surgery, laparoscopic hepatectomy is associated with a significantly lower risk of postoperative complications, including abdominal incision pain, infection, intraoperative bleeding, bowel dysfunction, delayed recovery, and prolonged hospitalization [2]. Moreover, there is no statistically significant difference between robot-assisted hepatectomy and the other two methods in terms of intraoperative blood transfusion rates, complication rates, operative time, or hospitalization time, but robot-assisted hepatectomy is more costly in China [3–6].

Laparoscopic resection of tumors in segment 7 of the liver is a prolonged procedure characterized by significant bleeding, especially in the context of obesity, the small size of the abdominal space, the large size of the liver, and unstable intraoperative liver transposition. Although liver traction modalities have been described in several papers [6–12], all have revealed several disadvantages such as their time-consuming nature, high risk of bleeding, instability, unsustainability, and unfeasibility; thus, we present a modified technique for bandwire extracorporeal traction in which the liver is transposed to varying degrees for adequate exposure, highlighting its utility for adequate exposure and therefore effective and precise hepatic tumor resection without damaging normal hepatic tissues. In this article, we present this technique and evaluate its feasibility and effectiveness in a retrospective case study.

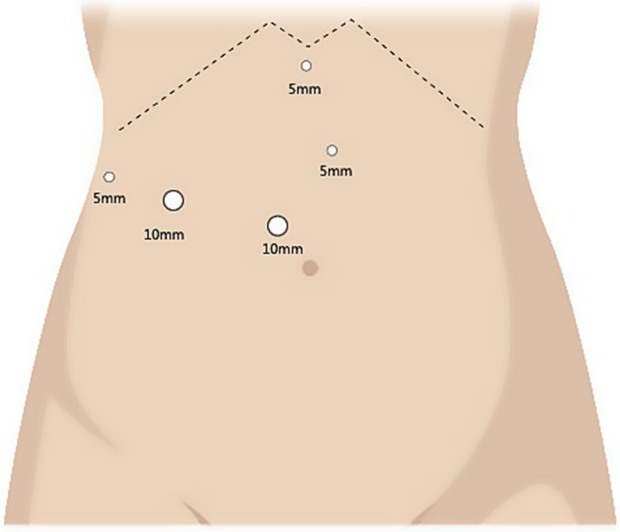

Fig. 1 Placement of the trocars for MILR

Patients and methods

The basic data of 15 patients who underwent laparoscopic surgery for S7 liver tumors at the Second Affiliated Hospital of Zhejiang University between January 2024 and November 2024 were collected. All surgeries were performed by the same surgeon. Demographic data (sex, age, body mass index), operative time, intraoperative blood loss volume, tumor size, tumor site, pathology type, surgical margins, and surgical complications were reviewed. We retrospectively analyzed the data and reported them as means and ranges. The study was approved by the Ethics Committee of the Second Affiliated Hospital of Zhejiang University. Patients were informed that their clinical data might be used for future studies.

Patient position

Patients were positioned left semilateral supine, with their head high and feet low at approximately 30 degrees. Under general anesthesia, patients were prepared for surgery, and the sight hole were made in the umbilicus for the placement of 10-mm trocars for observation. Carbon dioxide gas was then injected to establish pneumoperitoneum, and abdominal pressure was maintained at 12–14 mmHg. The operator was located on the right side of the patient, and 5-mm and 12-mm trocars were placed along the right anterior axillary line and the right mid-axillary line, respectively; the assistant was located on the left side of the patient, and two 5-mm trocars were placed in the epigastric region and the left side of the abdomen (see Fig. 1).

Modified traction device

Our retractor device consisted of a No. 1 absorbable suture (Ethicon Inc., Somerville, NJ, USA) and a large hem-o-lok clip (Zhejiang Kindly Medical Equipment Co., Ltd., China). Tie a knot at the end of a #1 absorbable suture., and a large hem-o-lok clip was placed in the center above the knot to clamp it closed (see Fig. 2). During the procedure, we retracted the right side of the liver to the left with this device, adjusting the tension at any time to ensure continuous exposure of the inverted liver, especially in obese patients and those with a large liver.

Traction procedure

The right perihepatic ligament is isolated first, and then a needle is passed through the relatively avascular area of the hepatic margin of S6. The side with the hem-o-lok clip is gently pulled to the dorsal margin of the liver. Then, the suture needle is passed through the left abdominal wall with the aim of adjusting the tension to ensure adequate and continuous exposure and then secured using vascular clamps at the site of skin puncture. Passing the suture needle through the abdominal wall not only allows adequate steering and traction but also allows for

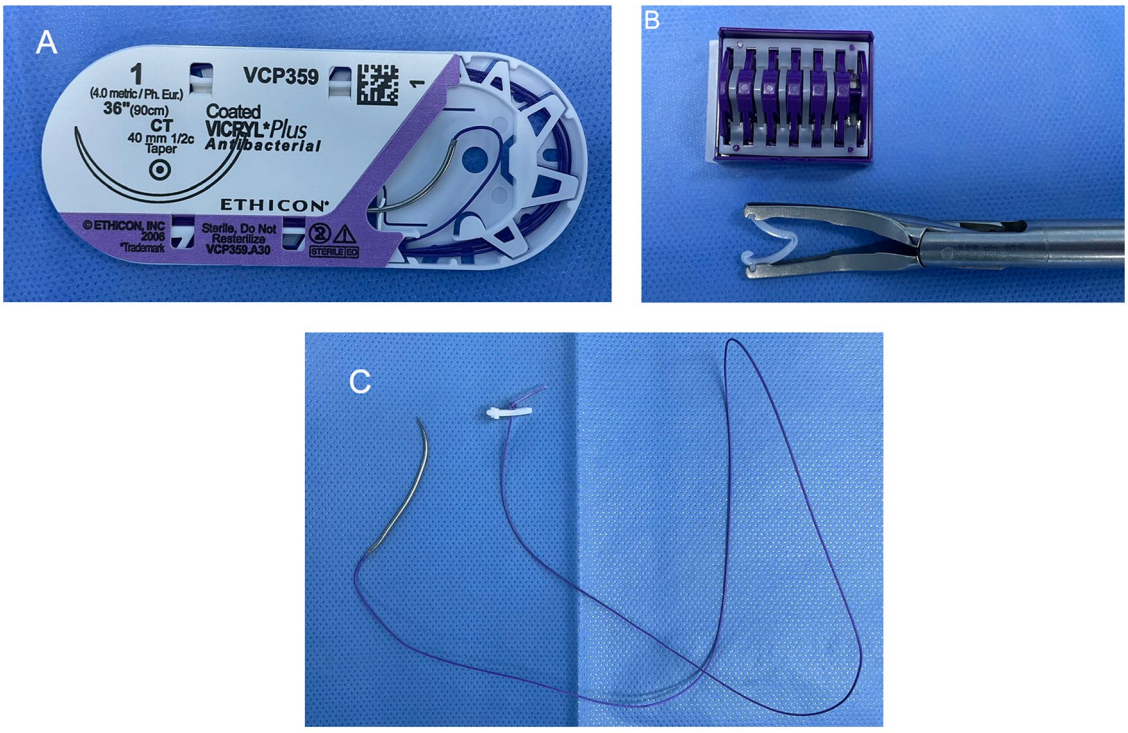

Fig. 2 Details of the traction device. A #1 absorbable suture was knotted at the end, and a large hem-o-lok clip was placed in the center above the knot to clip it closed (**A** and **B**), creating the traction device (**C**)

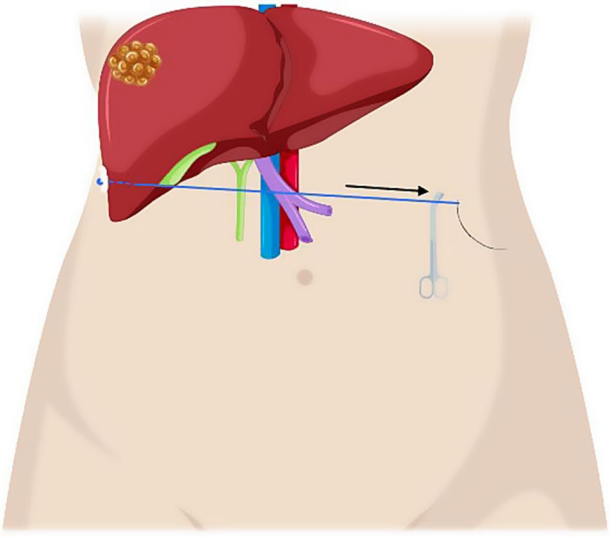

Fig. 3 Arrangement of traction devices. The suture thread was passed through the left abdominal wall to ensure proper tension and to expose the operative area, and then the suture thread was secured at the skin puncture site using vascular forceps. This allows for adequate steering and traction as well as appropriate adjustment of tension

appropriate and flexible tension adjustment (see Fig. 3). Mobilize the entire free right liver to the left and secure it with the traction device for continuous exposure of the surgical field.The traction device should be carefully placed; however, if there is a small amount of bleeding at the first puncture site, the suture should be tightened to stop the bleeding before subsequent traction placement attempts. When the procedure is complete, the same hem-o-lok clip is used to close the suture ventral to the puncture point, and the remaining retractor line is cut and subsequently removed. The other steps were the same as those in conventional surgery (see Fig. 4). The time to set up traction was less than 3 min (see Video 1).

Patient demographic and pathological characteristics

Data from 15 laparoscopic resections of tumors in S7 of the liver were reviewed in this study. The surgery was performed by the same attending surgeon. The study population consisted of 9 males and 6 females, and the median mean age was 61.84 ± 11.08 years (Table 1). The median body mass index was 25.65 ± 3.14 kg/m^2, the median tumor size was 3.78 ± 2.09 cm, the median operative time was 154.09 ± 31.97 min, the median intraoperative blood loss volume was 115.36 ± 51.26 ml, the time to install traction device was 2.37 ± 0.35 min and the median hospitalization time was 10.33 ± 2.09 days. Of the 15 patients who underwent laparoscopic resection, 7 had hepatocellular carcinoma (46%) and 8 had metastatic hepatic cancer (54%); moreover, the tumors were located on the surface of the liver in 3 patients and in the deeper part of S7 in 12 patients. R0 resection was achieved in all cases. One patient suffered from postoperative bile leakege which recovered from conservative

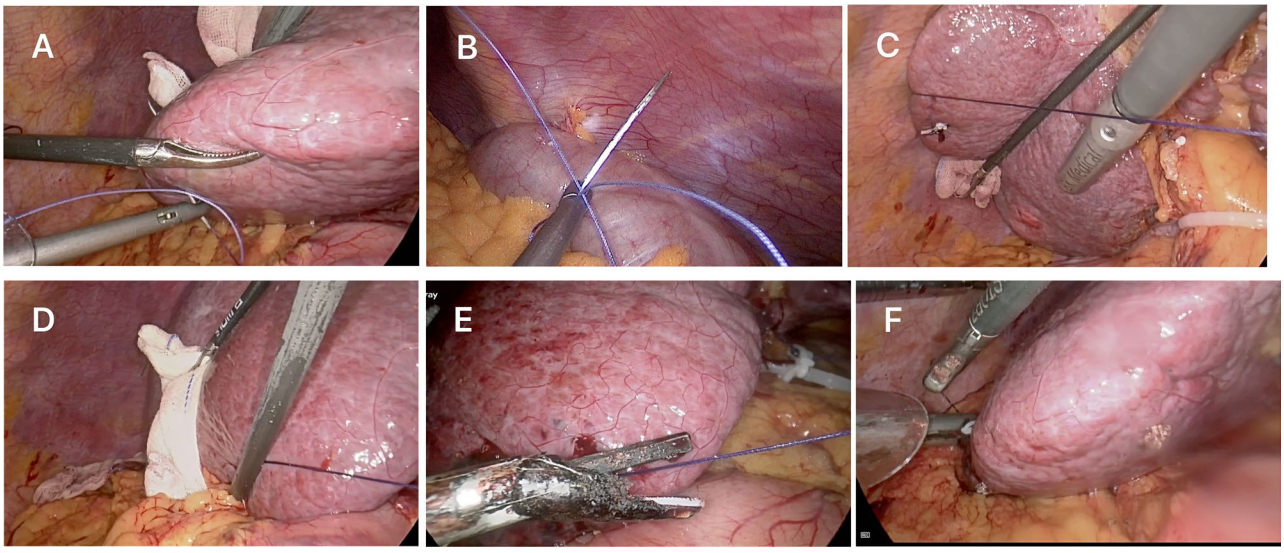

Fig. 4 Intraoperative images of modified bandwire extracorporeal traction. (**A**) The needle was passed through the relatively avascular area at the edge of S6. (**B**) The puncture needle was passed through the abdominal wall to the left. (**C**) The tumor and the needle hole were free of obvious bleeding. (**D**) The liver was turned to the left, and then the traction wire was pulled tightly then secured externally with vascular clamps. (**E**) The traction wire was severed using an ultrasonic scalpel during the postoperative period. (**F**) The stump of the wire was clamped closed using an absorbable clip

Table 1 Baseline characteristics of the patients and postoperative outcomes

	MILR(*n* = 15)
Sex	
Male	9
Female	6
Age	61.84 ± 11.08
Body mass index (BMI)(kg/m2)	25.65 ± 3.14
Surgical time(min)	154.09 ± 31.97
Intraoperative bleeding(ml)	115.36 ± 51.26
Tumor size(cm)	3.78 ± 2.09
Length of hospitalization(day)	10.33 ± 2.09
Time to install traction device(min)	2.37 ± 0.35
Pathological type	
Hepatocellular carcinoma	7
Metastatic liver cancer	8
Whether the tumor is located on the surface of the liver	
Yes	3
No	12
Whether R0 resection was achieved	
Yes	15
No	0
Postoperative complication	
Postoperative bile leak	1
Postoperative bleeding	0
Hydrothorax	1
Abdominal infection	0

treatment, 1 developed hydrothorax postoperatively, and the remaining patients had no significant complications. The use of this traction device allows for more sustained liver exposure, reduces liver injury due to mishandling, and improves surgical efficiency. There were no obvious serious postoperative surgical complications or unplanned secondary surgeries.

Discussion

Laparoscopic hepatectomy has been recognized as a safe and feasible treatment option for hepatic malignancies [13]. It is the most widely used in Chinese hospitals. Tumors located in the right posterior lobe of the liver requires a greater degree of liver transposition, and conventional exposure requires assistants to effectively collaborate for exposure of the surgical area.

Kirschner's needles, rubber strips, and other tools are commonly used to elevate the liver, thereby increasing the size and visibility of the surgical field; however, the use of such tools can still injure or cause bleeding of the abdominal wall and liver, thus precluding intraoperative adjustments at the operator's discretion [14]. Researchers reported the use of barbed wire for suture traction [11] and then its subsequent fixation in the abdominal wall. Because S7 of the liver needs to be steered for sustained traction, the use of minimally invasive surgical instruments for intra-abdominal traction can cause traction failure, especially since tension cannot be appropriately adjusted, thus increasing the operative time and the risk of bleeding. A rubber band retraction method has been described for the resection of S7 tumors [15]; however, this method requires multiple sutures to close the liver and intracavitary instruments to assist in traction, thus increasing the operation time.Woohyung Lee et al. reported the use of an intercostal port for resection of hepatic tumors in segment S7 [16], and Zenichi Morise reported the

left lateral position with an intercostal port for resection of the right posterior lobe [17], both of which resulted in better surgical outcomes. This requires more experience and better proficiency on the part of the surgeon. However, due to the intercostal anatomy, this approach still carries the potential risks of pneumothorax, bleeding, and postoperative pain. The supine position better maintains the patient's hemodynamic stability and facilitates the management of intraoperative emergencies. In patients with multiple liver metastases, intraoperative flexible position changes are more advantageous.

For optimal exposure of hepatic tumor, we modified a traction technique by using wires, which not only freed the surgical assistants' hands during the operation but also prevented injury to the liver tissue caused by repeated traction for continuous exposure. Moreover, the hem-o-lok clips used for the preparation of this device are readily available and inexpensive and can be used in any minimally invasive surgery performed at any hospital. All the participating physicians at our center agreed that the traction device was easy to use and took less than 3 min to set up.

The use of this device is more suitable for obese patients and those with a large liver. Operators should also commit to using the traction device gently. In all cases, we did not find any significant liver tear or injury; however, in cases where this traction technique was not used, the risk of injury to the normal liver was greater due to repeated pulling of laparoscopic instruments and inconsistencies in the assistant's maneuvers. Moreover, the advantage of extracorporeal traction is that the angle at which the liver is steered can be adjusted by adjusting the extracorporeal traction force, which is more convenient than in vivo adjustment with minimally invasive instruments is.

The application of our modified technique led to a more precise tumor resection and a lower risk of incising the tumor envelope. In our study, all patients who underwent surgery with our bandwire traction technique had histologically negative surgical margins.

The limitations of our study include its retrospective nature, lack of a control group, small sample size and institutional homogeneity.

Conclusion

Our preliminary experience was that extracorporeal traction with suture thread is safe and feasible, especially for difficult-to-resect hepatic tumors in S7. This modified traction technique made liver steering more convenient, significantly reduced the pulling of laparoscopic instruments and thus damage to normal hepatic tissues, helped expose the surgical area, reduced intraoperative bleeding, and shortened the surgical time.

Abbreviations

MILR Minimally-invasive liver resection
BMI Body mass index

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12893-025-02876-y.

Supplementary Material 1

Acknowledgements

Not applicable.

Author contributions

XY and AR contributed to the conceptualization and design of the study and drafting of the manuscript. XY and AR contributed to the collection and analysis of the data. JW helped supervise and interpret the data. BZ and SY conceived and supervised the whole project. All authors read and approved the final manuscript.

Data availability

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethics approval and consent to participate for the study were obtained from the Ethics Committee of The Second Affiliated Hospital of Zhejiang University School of Medicine. Informed consent was waived because of the retrospective nature of the study, and the Ethics Committee of The Second Affiliated Hospital of Zhejiang University School of Medicine also approved the informed consent waiver. All the study protocols were in accordance with Declaration of Helsinki.

Consent for publication

Not applicable. The manuscript does not contain any individual person's data, images, or other identifiable information.

Competing interests

The authors declare no competing interests.

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