SCIENTIFIC PAPER

Single-Incision Laparoscopic Surgery Versus Standard Laparoscopic Surgery for Unroofing of Hepatic Cysts

Shuodong Wu, MD, Yongnan Li, MM, Yu Tian, MD, Min Li, MM

ABSTRACT

Background and Objectives: The aim of this report is to document the feasibility and safety of umbilical single-incision laparoscopic liver cyst unroofing in the treatment of simple hepatic cysts in a retrospective case-control study. We also introduce some operative skills for single-incision laparoscopic surgery.

Methods: From May 2009 to July 2011, 15 patients underwent umbilical single-incision laparoscopic liver cyst unroofing. All the clinical data were retrospectively analyzed. Another 15 simple liver cyst patients who received standard laparoscopic liver cyst unroofing at our hospital during the same period—with a similar age, nature of the cyst, and position to the single-incision group—were selected to undergo a case-control study. The operative time, blood loss, recovery time of gastrointestinal function, volume of postoperative drainage, postoperative drainage time, postoperative hospitalization time, and postoperative recurrence rate were compared between the two groups.

Results: There was no significant difference between the single-incision group and standard group in operative time (58.3 ± 7.43 minutes vs 58.7 ± 6.14 minutes), blood loss (17.0 ± 3.19 mL vs 14.7 ± 1.86 mL), recovery time of gastrointestinal function (2.5 ± 0.22 days vs 2.4 ± 0.22 days), volume of postoperative drainage (408.0 ± 119.5 mL vs 450.0 ± 89.5 mL), postoperative drainage time (2.6 ± 0.55 days vs 3.7 ± 0.59 days), or postoperative hospitalization time (4.8 ± 0.44 days vs 5.2 ± 0.56 days) ($P > .05$). The postoperative follow-up period was 1 to 24 months.

Conclusions: Compared with standard laparoscopic liver cyst unroofing, single-incision laparoscopic liver cyst unroofing shows no significant difference during the overall treatment process. In addition to the advantages of less trauma, more rapid recovery, and shorter hospital stay, single-incision laparoscopic surgery can reach the effect of “no scar” and can be safely and effectively carried out.

Key Words: Single-incision laparoscopic surgery (SILS), Hepatic cyst, Laparoscopy.

Department of Biliary & Vascular Surgery, Shengjing Hospital of China Medical University, Shenyang, China (all authors).

Acknowledgment: We thank the Information Office of Shengjing Hospital for its valuable data search assistance in the preparation of the manuscript.

Address correspondence to: Shuodong Wu, MD, Department of Biliary & Vascular Surgery, Shengjing Hospital of China Medical University, San Hao Street Shenyang City, Liaoning Province, China. Telephone: +86024–96615–1-31211, E-mail: wushuodong@yahoo.cn

DOI: 10.4293/108680813X13753907291512

INTRODUCTION

A liver cyst is a common benign disease of the liver. According to these cysts' etiology, they can be divided into parasitic and nonparasitic hepatic cysts. Nonparasitic hepatic cysts can further be divided into congenital and acquired hepatic cysts. On the basis of their different etiology, congenital liver cysts are divided into simple hepatic cysts and polycystic liver disease. Currently, laparoscopic liver cyst unroofing is the preferred method for the treatment of simple hepatic cysts.[1]

As the single-incision laparoscopic surgery (SILS) technology rising in recent years matures, applying this technique to the treatment of simple hepatic cysts has become possible. By comparing the clinical case data for single-incision and standard laparoscopic liver cyst unroofing, this article evaluates the effects of the two operative methods and the application prospects of single-incision laparoscopic liver cyst fenestration.

METHODS

Patients and Perioperative Data

Between May 2009 and July 2011, 15 patients (7 men and 8 women) who were randomly selected underwent single-incision laparoscopic liver cyst unroofing in our ward, after we obtained approval from the Ethics Committee of Shengjing Hospital and informed consent from each patient. Perioperative data, including patient age, sex, body mass index (BMI), site of cyst, cyst characteristics, operative time, blood loss, recovery time of gastrointestinal function, volume of postoperative drainage, postoperative drainage time, and postoperative hospitalization time, were prospectively collected and compared with those of another 15 patients who underwent standard laparoscopic liver cyst unroofing during the same period. All the patients were preoperatively diagnosed with simple hepatic cysts depending on the history, physical examination findings, ultrasonography, and enhanced computed tomography (CT) or magnetic resonance imaging. The surgical indications included a cyst diameter >5 cm accompanied by abdominal pain, nausea, and other symptoms or rapid growth of the cyst in a short period. All procedures were performed by the same surgeon (S.W.).

Surgical Techniques

The patient was placed in the French position under general anesthesia with endotracheal intubation. The surgeon stood between the legs. The patient was rotated to the right or left according to the location of the cyst. Clever use of the body position transformation could obtain a better field of vision. Pneumoperitoneum in the single-incision group was constructed through the umbilicus. Then, one 10-mm trocar containing a laparoscopic camera was inserted through the umbilicus. One 2.5-cm incision on the upper edge of the umbilicus should be designed along the ventral midline. We had to retain the integrity of the fascia because it was the key point to maintaining pneumoperitoneum tightness. After that, making use of skin ductility, skin retractors fully expanded the incision along the horizontal direction. Two 5-mm trocars were inserted into the abdominal cavity from the site of the skin retractors, with a distance >2.5 cm between them. Thus, the two 5-mm trocars together with the 10-mm trocar formed an inverted triangle (**Figure 1**).

The initial step involved fenestration of the cyst in the center by ultrasonic scalpel (LCS; Ethicon, Cincinnati, Ohio) and aspiration of the entire cyst contents. The cyst wall was then resected at the junction of the cyst and liver parenchyma with the ultrasonic scalpel. The back wall of the cyst should be checked carefully for evidence of bile leak. If there was no bile leak identified, no further treatment was required. For cases of multiple hepatic cysts, only the largest cyst or the cyst located near the surface of the liver was fenestrated. The resected cyst wall was removed through the 10-mm trocar and routinely sent for permanent, not frozen, histopathologic evaluation (**Figure 2**).

Ten patients in the single-incision group underwent placement of an abdominal drainage tube that was removed only when the drainage volume decreased, no bleeding or bile leakage was found, and no abdominal cavity effusion was found by ultrasonography postoperatively through the umbilical port (**Figure 3**). Finally, the trocar site was closed with an absorbable suture (**Figure 4**).

Figure 1. Construction of umbilical channel by conventional instruments.

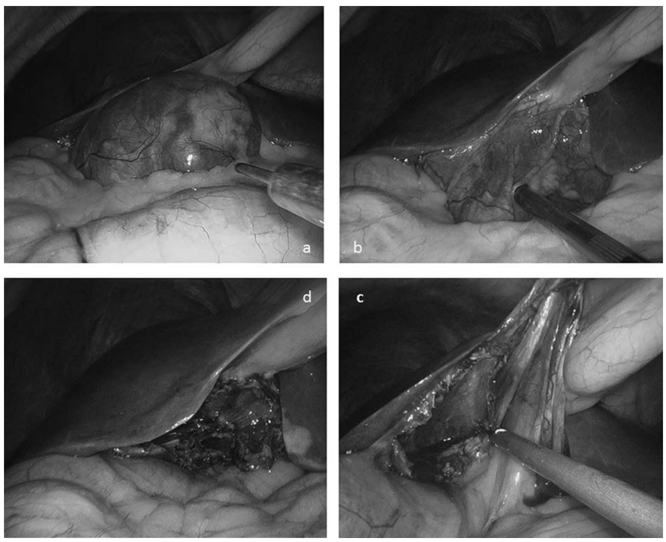

Figure 2. Single-incision laparoscopic hepatic cyst unroofing shown in brief.

The operative procedure in the standard group was similar to that in the single-incision group. One 10-mm trocar was inserted into the abdominal cavity through the umbilicus as an observation port. The main operating hole was built by another 10-mm trocar located under the xiphoid,

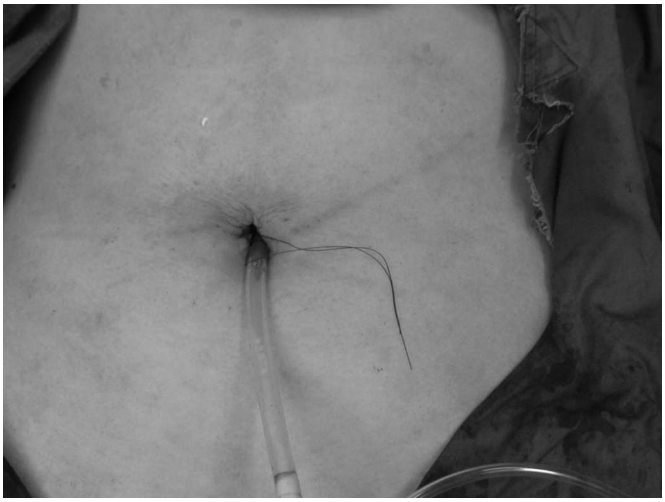

Figure 3. Umbilical incision at end of SILS procedure with drainage tube.

Figure 4. Stitched umbilicus. The BMI of this patient was 20.5 kg/m². (The normal range in Asians is 18.5–22.9 kg/m².)

and the other hole was in the right upper quadrant of the abdomen, constructed by a 5-mm trocar at the medioclavicular line. In the standard group, 13 patients underwent placement of an abdominal drainage tube immediately after surgery.

RESULTS

Table 1 summarizes the patient demographic and hepatic cyst characteristics. Fifteen SILS hepatic cyst unroofing procedures were performed in 15 patients and were compared with 15 standard laparoscopic hepatic cyst unroofing operations. There were no significant differences between the SILS and standard groups in age, BMI, or largest cyst diameter. Patients' cysts were located in the left lobe in 11 patients in the SILS group but only 9 patients in the standard group. Multiple hepatic cysts were diagnosed in 2 patients in the SILS group and 4 patients in the standard group.

Table 1.
Patient Demographic and Hepatic Cyst Characteristics

Variable	SILS Hepatic Cyst Unroofing	Standard Hepatic Cyst Unroofing	*P* Value
No. of patients	15	15	
Age (mean ± SD) (y)	60.93 ± 9.41	58.67 ± 7.83	.371
Sex	Male, 7; female, 8	Male, 6; female, 9	
BMI (mean ± SD) (kg/m²)	22.75 ± 1.54	23.13 ± 1.21	.361
Largest cyst diameter (mean ± SD) (cm)	11.67 ± 3.66	11.27 ± 2.22	.95
Site of cyst			
Left lobe (S2–S4)	11	9	
Right lobe (S5–S8)	4	5	
Type of cyst			
Single cyst	13	11	
Multiple cysts	2	4	

Perioperative Results

The laparoscopic procedure was successfully performed in all patients in both groups. In the SILS group, there were no conversions to a standard laparoscopic or open operation. In the standard group, there were no conversions to an open operation. **Table 2** shows that there were no statistically significant differences between the SILS group and the standard group in operative time, blood loss, recovery time of gastrointestinal function, postoperative drainage volume, postoperative drainage time, and postoperative hospitalization time.

Follow-Up

All cases were followed up by telephone every 3 months, and ultrasonography was recommended as the routine postoperative examination. None of the patients had umbilical incision complications. The follow-up period ranged from 1 to 24 months, and the mean follow-up period was 12.26 ± 8.32 months in the SILS group and 14.0 ± 8.04 months in the standard group. In the SILS

Table 2.
Perioperative and Postoperative Findings

Variable	SILS Hepatic Cyst Unroofing (Mean ± SD)	Standard Hepatic Cyst Unroofing (Mean ± SD)	*P* Value
Operative time (min)	58.3 ± 7.43	58.7 ± 6.14	.431
Blood loss (mL)	17.0 ± 3.19	14.7 ± 1.86	.449
Recovery time of gastrointestinal function (d)	2.5 ± 0.22	2.4 ± 0.22	.505
Postoperative drainage volume (mL)	408.0 ± 119.5	450.0 ± 89.5	.077
Postoperative drainage time (d)	2.6 ± 0.55	3.7 ± 0.59	.138
Hospital stay (d)	4.8 ± 0.44	5.2 ± 0.56	.332

group, only 1 patient was followed up for 1 month whereas 4 patients had follow-up periods >20 months. During the follow-up period, there was 1 patient in the SILS group examined for recurrence by ultrasonography, but enhanced CT compared with the preoperative CT scan confirmed that enlargement of the original cyst in the hepatic parenchyma had occurred.

DISCUSSION

Hepatic cyst is a common benign liver disease. It is more common in patients aged >50 years, and the incidence varies from 2.5% to 5%.[1] Usually, these cysts are small, but even large cysts may remain asymptomatic. Only about 15% patients have symptoms, and the incidence is higher in female patients than in male patients, especially in middle-aged and old women.[2] If the diagnosis is clear, most patients are not in need of treatment unless they have abdominal pain or nausea with a cyst diameter >5 cm or if the cyst grows rapidly within a short period.[3,4]

Nowadays, the main therapies for liver cysts include traditional open operation, needle aspiration guided by ultrasonography or CT, and laparoscopic liver cyst unroofing. However, the interventional therapy always shows a higher recurrence rate for hepatic cysts.[2] Along with the maturity of the technique and the development of equipment in laparoscopic surgery, laparoscopic liver cyst unroofing has become the preferred treatment method for simple liver cysts because of its exact therapeutic effect, the shorter postoperative hospitalization time, less postoperative pain, the lower cyst recurrence rate, and other advantages.

Laparoscopic surgery is a modern surgical technique that has brought a number of advantages to patients, including reduced pain, shorter recovery time, and cosmetic benefits. Recently, the tendency of this procedure is to minimize the number of incisions. Under this concept, SILS has come into being. Actually, SILS is not a new concept. It was described in 1992 by Pelosi and Pelosi,[4] who successfully performed a single-puncture laparoscopic appendectomy. In recent years, many surgeons have focused on this technique as an improvement of traditional standard laparoscopic surgery. We should recognize that reducing the number of incisions not only yields cosmetic benefits but also lowers the incision risk, as well as reducing the morbidity of bleeding, incisional hernia, and organ damage.

All of the single-incision laparoscopic liver cyst unroofing procedures in the 15 patients in the single-incision group were successfully performed, with no transition to standard laparoscopic operations. This finding shows that single-incision laparoscopic liver cyst unroofing is technically feasible. In the single-incision laparoscopic operation, the operational channel could be constructed by a dedicated port, such as SILS Port (Covidien, MA, USA), Alexis® Gel Port (Applied Medical, Rancho Santa Margarita, CA, USA), and so on. However, in our single-incision group, we just used the common laparoscopic instruments to construct the channel (**Figure 1**), which reduced the patients' treatment cost and was conducive to the promotion and application of the technology. Compared with the standard group, the single-incision group had no significant differences in operative time, blood loss, recovery time of gastrointestinal function, and postoperative hospitalization time, which illuminated that with the conventional laparoscopic instruments, single-incision laparoscopic liver cyst unroofing could achieve the therapeutic level of the standard laparoscopic operation when the liver cyst was suitable for laparoscopic treatment. Postoperative follow-up results indicated that in the recent follow-up period, SILS could reach the therapeutic effect of the traditional laparoscopic operation. However, long-term follow-up observation is still necessary.

If the cyst is relatively small and the liquid in the cyst is clear, postoperative abdominal drainage is not necessary. However, if the liver cyst is large and especially if the liquid in the cyst is brown or bile like, a drainage tube must be placed immediately after surgery. The tube can only be removed after one confirms there is no bleeding or bile leakage and reduced drainage volume. By comparing the postoperative drainage volume of the two groups, we found no differences in the drainage effect between the transumbilical tube and the tube in the traditional position. Before removal of the drainage tube in the single-incision group, abdominal ultrasonography was used to detect the effect of transumbilical drainage, and only a small amount of liquid could be found in the abdominal cavity. The results indicated that transumbilical drainage was effective and there was no inadequate, incomplete, or ineffective drainage. After removal of the umbilical drainage tube, the incision should be sutured with the patient under local anesthesia, which could truly achieve the effect of a scar-free abdominal wall (**Figures 3** and **4**).

The key technical problem with SILS is how to avoid collisions between instruments during the operation. When conventional laparoscopic instruments are used, this collision becomes more obvious. The collision not only occurs between the instruments' arms in the abdominal cavity but also occurs between the handles of the instruments outside the abdomen (e.g., the handles of the ultrasonic scalpel, laparoscopic telescope, and other instruments).

Petrotos and Molinelli[5] also used routine laparoscopic trocars, but they did not mention the exact insertion site of the trocar. The cable of the telescope and the tail side of the trocar can also cause problems during the operation. Sometimes, this kind of interference is inevitable in surgery, but with practice, we have found that there are still some ways to effectively reduce the occurrence of such interference. At first, when the umbilical incision is established, the incision should be longitudinally cut and measure about 2 cm. Then, skin retractors pull the incision horizontally by at least 2.5 cm so that the maximum distance between the two 5-mm trocars can be achieved (**Figure 5**). This is very important because if the two punctures are too close, the instrument handles will easily become intertwined with each other, and this may cause leaking as well, making it difficult to maintain adequate pneumoperitoneum pressure. In his report, Sinha[6] emphasized the collinear relationship of trocars. However, in our opinion, although this rule is important, it is not the key or the essence to avoiding collision during the procedure. We think that the 3 trocars should be arranged in an inverted triangle but their tail sides must not be in the same plane; instead, a ladder-like arrangement is necessary for the trocars' tails (**Figure 6**). Because we cannot always keep the 3 instruments in the same line during the procedure, if the tail sides of the trocars are in the same plane, collision will become inevitable. After all, collision between two thick tails of trocars is much more likely than collision between one thick trocar's tail and one thin cannula of another trocar. In this manner, one can also obtain more operational space.

When one is using conventional laparoscopic instruments, interference between the telescope-holding assistant and operator is very common. If we consider the laparoscopic instruments from Stryker (Kalamazoo, Michigan), for example, the main interference outside the abdominal cavity occurs between the cable of the telescope and the handles, but inside the abdominal cavity, it is between the arm of the instruments and the telescope. Sinha[6] said that to minimize the collision between instruments and the telescope, both the light cord and CO_2 cord should be kept vertically upward in the same line. We tried this method but failed. Using this method, we could not obtain a good view during the procedure. In our practice, we learned that the CO_2 cord should be kept

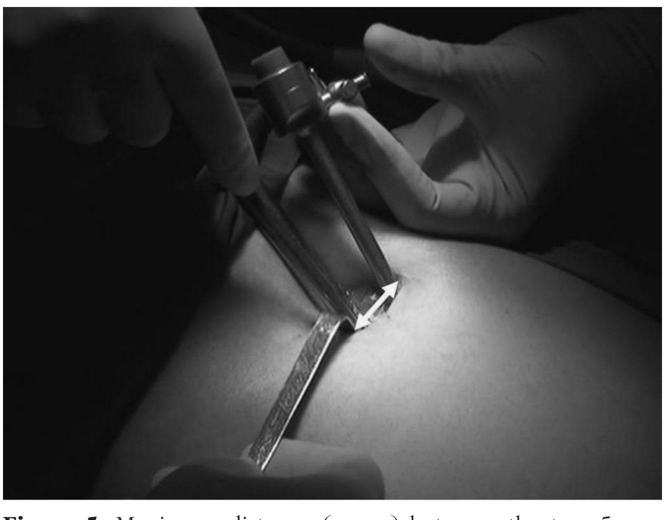

Figure 5. Maximum distance (arrow) between the two 5-mm trocars.

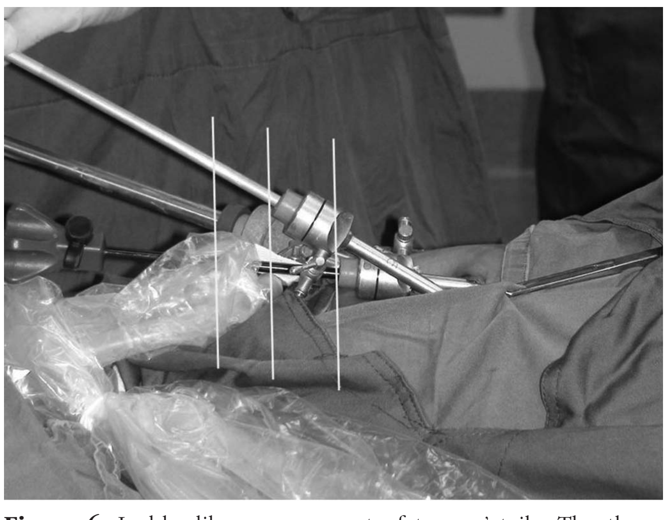

Figure 6. Ladder-like arrangement of trocars' tails. The three horizontal lines show the different level of trocars's tails.

horizontal and cling to the body of the patient. A rigid 30° telescope should be used to view the operative field from one side of the main instrument (always an ultrasonic scalpel in our patients) (**Figure 7**). The direction of the light cord could be vertical or horizontal just to avoid collision with the handles of the instruments. To avoid interference between instruments and the telescope, when collision happens, the telescope needs to be withdrawn appropriately from the abdominal cavity. Considering the main operative instrument as an axis, the telescope then rotates to the left or right before returning to the abdominal cavity. The two operational instruments in the abdominal cavity should move in an orderly manner; that is to say, the assistive instrument should be fixed after exposing the operative field, and then the main operating instrument can start moving. When the stretch position of the assistive instrument needs to be changed, the main operational instrument should be fixed first and then the assistive instrument is moved. Thus we have to avoid simultaneous movement of the two instruments in the abdominal cavity. Sometimes, the two operative instruments in a crossed state can be used to complete some difficult procedures that could hardly be performed in a parallel state. With practice, a suitable point of view can always be found, and good exposure of the surgical field can also be obtained; besides, there will be a noticeable decline in collision of instruments.

Although a large number of clinical case studies are demanded, we still provide some suggestions for SILS: (1) In the early stage, we recommend selecting patients with a BMI in the normal range (18.5–22.9 kg/m^2 for Asians). The recommendation is made because when the surgeon is not familiar with the SILS technique, fat bodies may increase operative difficulties and decrease the success rate. (2) After one establishes pneumoperitoneum and inserts the telescope into the abdominal cavity, if the telescope cannot directly observe the liver cyst, the patient is not suited for SILS surgery. This is because in these kinds of cases, most cysts are located at the right posterior lobe of the liver. If the surgeon resects the cyst wall from the anterior surface of the liver (from the S5 segment to S8 and to S7 [pathway]), it will be very difficult for him or her to succeed even though he or she uses elongated flexible instruments. Moreover, some important vessels in the second hepatic portal could be easily damaged because of a poor visual field. If the surgeon resects the cyst wall from the right side of the liver (along the S6 segment to S7, clinging to the lateral abdominal wall), collision may seriously interfere with the operation because the 2 instruments and the telescope have to coexist in a cramped space.

Figure 7. The CO_2 cord should be kept horizontal and close to the body of the patient. The direction of the light cord could be vertical or horizontal just to avoid collision of the handles of the instruments.

By comparing the therapeutic results of the two different surgical methods, we found that the single-incision operation retains the advantages of traditional laparoscopic surgery and has no significant differences compared with multi-incision laparoscopic operations in many aspects of treatment. In addition, the single-incision operation has the same cosmetic effect as interventional puncture.

References:

1. Szabo L, Takacs I, Arkosy P, Sapy P, Szentkereszty Z. Laparoscopic treatment of nonparasitic hepatic cysts. *Surg Endosc*. 2006;20:595–597.

2. Tan YM, Hung AC, Mack P, et al. Role of fenestration and resection for symptomatic solitary liver cysts. *ANZ J Surg*. 2005; 75:577–580.

3. Zacherl J, Scheuba C, Imhof R, et al. Long-term results after laparoscopic unroofing of solitary symptomatic congenital liver cysts. *Surg Endosc*. 2000;14(1):59–62.

4. Pelosi MA, Pelosi MA III. Laparoscopic appendectomy using a single umbilical puncture (minilaparoscopy). *J Reprod Med*. 1992;37:588–594.

5. Petrotos AC, Molinelli BM. Single-incision multiport laparoendoscopic (SIMPLE) surgery: early evaluation of SIMPLE cholecystectomy in a community setting. *Surg Endosc*. 2009;23: 2631–2634.

6. Sinha R. Transumbilical single-incision laparoscopic cholecystectomy with conventional instruments and ports: the way forward? *J Laparoendosc Adv Surg Tech A*. 2011;21(6): 497–503.