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# Laparoscopic-Assisted Combined Colon and Liver Resection for Primary Colorectal Cancer with Synchronous Liver Metastases: Initial Experience

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**Abstract**
*Background* Laparoscopic approaches have become increasingly used in selected patients with either colorectal or liver cancer. However, the feasibility of laparoscopic-assisted combined colon and liver resection in primary colorectal cancer with synchronous liver metastases remains unknown. The aim of the present study was to determine the feasibility of laparoscopic-assisted combined colon and liver resection for primary colorectal cancer with synchronous liver metastases.
*Methods* Laparoscopic surgery involving intestinal anastomosis was performed for primary colorectal cancer. The liver was then mobilized with the assistance of a hand inserted through the upper midline incision. For minor resections, the parenchymal transection was performed laparoscopically. For major resection involving a hilar dissection, transection was performed according to the standard open techniques under direct vision through the incision. Resected specimens were retrieved directly through the midline incision.
*Results* Ten patients with primary colorectal cancer and synchronous liver metastases underwent the above procedure between September 2006 and April 2007. Surgical procedures for colorectal cancer included 5 low anterior resections, 3 anterior resections, 1 right hemicolectomy, and 1 subtotal colectomy. Combined hepatic surgery included 6 major hepatectomies, 3 segmentectomies, and 1 tumorectomy. All procedures were successful, with no conversions to open surgery required. The median operation time was 439 min (range: 210–690 min), and the median estimated blood loss was 350 ml (range: 300–1,200 ml). There was no surgical mortality or major morbidity, except in one patient in whom postoperative bleeding at the site of para-aortic node dissection was promptly controlled.
*Conclusions* Laparoscopic-assisted combined colon and liver resection is a feasible and safe procedure for the treatment of primary colorectal cancer with synchronous liver metastases.

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## Introduction

Approximately 25% of colorectal cancer patients have detectable synchronous liver metastases at the time of presentation [1]. Overall survival in such patients is closely related to tumor burden, and improvements in surgical technique have resulted in liver resection becoming the treatment of choice, with 5-year survival rates reaching 35–40% [2]. Simultaneous resection of both the colorectal primary tumor and liver metastases can be considered irrespective of the primary location and the type of liver resection because simultaneous resection does not increase mortality or morbidity rates and does not decrease overall survival compared with staged resection [3, 4].

A laparoscopic-assisted approach for colorectal cancer surgery has been recently developed, and this approach is being increasingly applied following demonstrations of its oncological safety in randomized prospective trials during the first decade of the twenty-first century [5–9). The indications for laparoscopic surgery are now considered the same as those for open surgery on the colon and rectum [10]. In addition, recent studies reported that liver resection, including major hepatectomies, can be safely performed laparoscopically [11], and the outcomes include reduced surgical blood loss, earlier recovery, and oncologic clearance comparable with conventional open surgery [12].

The development of laparoscopic techniques and instruments has made simultaneous resection of synchronous lesions an attractive option. Although laparoscopy has become increasingly used in selected patients with either colorectal or liver cancer, laparoscopic-assisted combined colon and liver resection for primary colorectal cancer with synchronous liver metastasis has seldom been performed, and the efficacy of the procedure remains unknown. To our knowledge, there is only one case report describing laparoscopic combined colon and liver resection for colorectal cancer with synchronous liver metastases [13].

The present study was designed to gain further knowledge of laparoscopic-assisted combined colon and liver resection for primary colorectal cancer with synchronous liver metastases. This report describes the surgical outcomes of 10 such cases. The knowledge gained will assist in determining whether this is a feasible and safe treatment option for these patients.

## Materials and methods

From September 2006 to April 2007, 10 patients at our institution were diagnosed with primary colorectal cancer and synchronous liver metastases. All patients underwent preoperative work-ups, including digital rectal examination (DRE), complete blood count, liver function test, coagulation profiles, carcinoembryonic antigen (CEA) measurement, colonovideoscopy with biopsy, computed tomography (CT) scanning of the abdomen and pelvis, and F-18 deoxyfluoroglucose positron emission tomography (FDG-PET). Magnetic resonance (MR) scanning of the liver was performed as required. All liver metastases were diagnosed from preoperative abdominal CT and FDG-PET studies. No patients received preoperative chemotherapy. All procedures were performed after obtaining informed consent from the patients. No epidural blocks were used. Elastic stockings were instituted for antithrombotic prophylaxis. After an endotracheal general anesthesia, a urinary catheter and arterial and central venous lines were inserted. Colorectal resection was followed by liver resection in all cases.

### Colorectal surgery

Patients were positioned in the Trendelenberg-with-modified-lithotomy position, with arms adducted. An 11-mm subumbilical port was created to facilitate the formation of a pneumoperitoneum ($CO_2$ at 12 mmHg), and a 30-degree laparoscope was then inserted to explore the peritoneal cavity. Four additional ports were created to facilitate dissection (Fig. 1). Vessels were controlled close to their origin using intracorporeal endoscopic clips. Following bowel mobilization and vessel division, the tumor-bearing segment was retrieved through a small upper midline incision with adequate wound protection. For right-sided colonic lesions, resection and anastomosis were performed extracorporeally. For left-sided or rectal lesions, anastomosis was performed intracorporeally with a circular stapler.

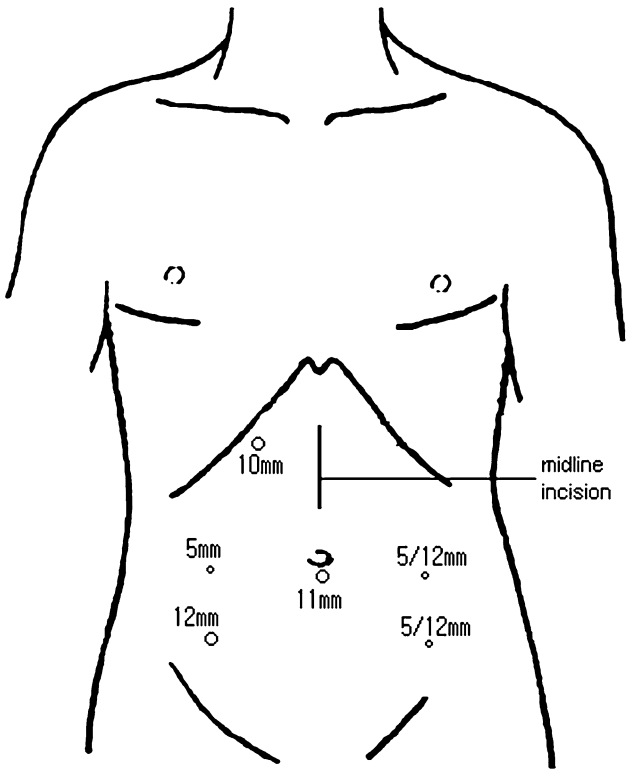


**Fig. 1** For colorectal surgery, an 11-mm port inferior to the umbilicus (for the camera) and four 5/12 mm ports in four quadrants (for dissection) were created. For the combined liver surgery, a 10-mm port was added in the right subcostal area for instruments, and a median 12 cm (range 5–15) upper midline incision was created for hepatic parenchymal dissection

Liver surgery

After colorectal surgery, the patient was moved into a reverse Trendelenberg position. Once the liver was visualized, one additional 10-mm port was placed at a convenient site, and the midline incision that had been used to extract the colon specimen was used as a hand port for further liver mobilization and specimen extraction. The liver was partially or completely mobilized depending on the extent of resection. For minor resections such as segmentectomy or tumorectomy, the parenchymal transection was performed laparoscopically with an ultrasonic dissection device. For major resections involving more than a right posterior sectionectomy with the right hepatic vein, once the liver was mobilized enough to expose the retrohepatic inferior vena cava (IVC) or the ligamentum venosum (depending on a right or left hepatectomy), the hand port and all other laparoscopic devices were removed and an abdominal wall retractor was positioned in the upper midline incision (Fig. 2). Further extrahepatic hilar and major venous dissection was then undertaken to locate a hanging tape along the anteromedial surface of the retrohepatic IVC or the ligamentum venosum with its upper end among the 3 hepatic veins and its lower end among the 3 Glisson's pedicles. The parenchymal transection by means of a hanging maneuver was performed with the ultrasonic dissection device under direct vision through the upper midline incision [14]. The portal pedicle was divided en masse after the parenchymal transection or after being dissected into its artery, portal vein, and bile duct. The CVP was routinely kept below 5 mmHg during liver parenchymal transection. The resected liver specimen was then removed directly through the midline incision without any morcellation or compression (Fig. 3).

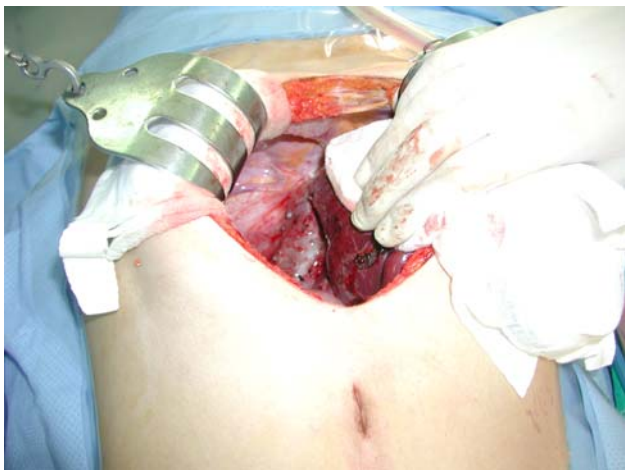

**Fig. 2** Mobilization of right liver with the anterior surface of the IVC exposed

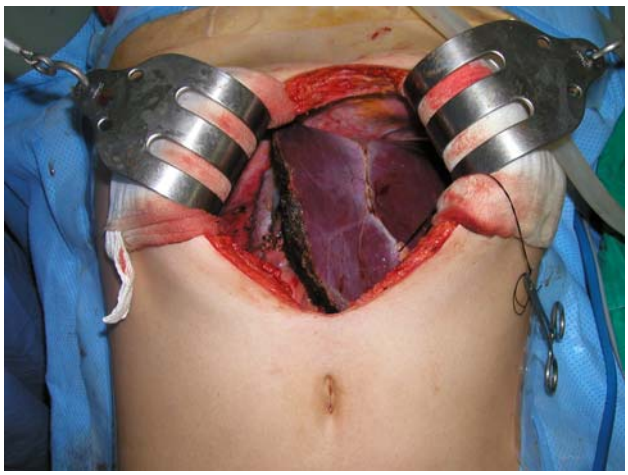

**Fig. 3** Operative view after right hepatectomy

## Results

Laparoscopic-assisted combined colon and liver resection was performed in a total of 10 patients with primary colorectal cancer and synchronous liver metastases. All surgery was performed with the intention of R0 treatment. Patient characteristics and surgical outcomes are summarized in Table 1. There were 6 male and 4 female patients, with a median age of 59.5 (45–77) years. All operations were successful, with none requiring conversion to open surgery. The median duration of oeration was 439 min (range: 210–690 min) and the median upper midline incision length was 12 cm (range: 5–15 cm). The median estimated blood loss (EBL) during surgery was 350 ml (range: 300–1,200 ml), and no patients required intraoperative transfusion. Salient pathological data and postoperative outcomes are listed in Table 2. There was no surgical mortality or major morbidity except for one patient who underwent reoperation through the upper midline wound on postoperative day 1 because of bleeding in the area of the para-aortic lymph node dissection. Other patients had uneventful, rapid postoperative recoveries. The median postoperative hospital stay was 15.5 days (range: 9–27 days) and was affected by postoperative morbidities (1 bleeding, 1 wound infection).

## Discussion

Close contact and cooperation between colorectal and liver surgeons at our institution has resulted in combined colorectal and liver resections for patients with colorectal cancer and synchronous liver metastases. From October 2000 to August 2006, we performed 130 such combined colon and liver resections. In addition, in the past 3 years we have performed 570 laparoscopic procedures for

**Table 1** Patient characteristics and surgical outcomes

| Case | Sex/age (years) | BMI ($kg/m^2$) | Location of colon cancer | Location of liver metz | Colon op | Liver op | Op time[a] (min) | Incision[a] (cm) | EBL[a] (ml) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | F/64 | 22.3 | Ascending | S5, 6 | Rt hemi | S5, 6 segmentectomy | 450 | 7 | 300 |
| 2 | M/59 | 22.9 | Rectum (AV10 cm) | S5, 6 | LAR | S5, 6 segmentectomy | 428 | 7 | 300 |
| 3 | F/45 | 24.0 | Sigmoid | S5, 6 | AR | Rt hemihepatectomy | 355 | 15 | 300 |
| 4 | M/68 | 27.8 | Rectum (AV 7 cm) | S4, 5, 6, 8 | LAR | Extended rt hemihepatectomy | 690 | 15 | 1200 |
| 5 | F/54 | 23.5 | Rectum (AV 10 cm) | S8 | LAR | Rt. Trisegmentectomy | 469 | 15 | 300 |
| 6 | M/61 | 19.1 | Sigmoid | S5, 6 | Subtotal | Rt hemihepatectomy | 473 | 12 | 400 |
| 7 | M/60 | 23.7 | Sigmoid | S6 | AR | Rt hemihepatectomy | 275 | 12 | 500 |
| 8 | M/77 | 22.8 | Rectum (AV 5 cm) | S4 | LAR | Lt hemihepatectomy | 510 | 12 | 1100 |
| 9 | M/54 | 23.5 | Sigmoid | S4 | AR | S4 tumorectomy | 210 | 5 | 300 |
| 10 | F/50 | 21.5 | Rectum (AV 10 cm) | S7 | LAR | Rt posterior sectionectomy | 326 | 12 | 400 |

*BMI* body mass index; *metz* metastases; *op* operation; *EBL* estimated blood loss; *Rt hemi* right hemicolectomy; *LAR* low anterior resection; *AR* anterior resection; *Subtotal* subtotal colectomy

[a] Median operative time: 439 min; median length of incision: 12 cm; median EBL: 350 ml

**Table 2** Pathological data and postoperative outcomes

| Case | Colon pathology | | | | | Liver pathology | | | SBD[c] (day) | Hospital stay[c] (day) | Morbidity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Size[a] (cm) | T stage | N stage | LN_T[a] | LN_P | No. | Size[b] (cm) | Margin (cm) | | | |
| 1 | 4.3 | 3 | 2 | 40 | 7 | 2 | 2.0 | 0.9 | 5 | 9 | None |
| 2 | 6.0 | 4 | 2 | 27 | 6 | 2 | 1.5 | 0.5 | 5 | 16 | None |
| 3 | 6.0 | 3 | 2 | 40 | 6 | 2 | 3.2 | 6 | 5 | 19 | None |
| 4 | 4.7 | 3 | 2 | 43 | 14 | 9 | 4.0 | 0.1 | 6 | 10 | None |
| 5 | 5.0 | 3 | 2 | 37 | 4 | 1 | 3.3 | 0.3 | 5 | 15 | None |
| 6 | 5.0 | 3 | 2 | 99 | 9 | 6 | 3.0 | 0.6 | 7 | 27 | Bleeding[d] |
| 7 | 7.5 | 4 | 1 | 42 | 1 | 1 | 4.0 | 2.1 | 6 | 17 | None |
| 8 | 3.6 | 3 | 1 | 19 | 1 | 1 | 4.0 | 4.2 | 4 | 27 | Wound infection |
| 9 | 4.0 | 4 | 2 | 36 | 8 | 1 | 0.9 | 0.5 | 6 | 10 | None |
| 10 | 5.0 | 3 | 2 | 48 | 9 | 1 | 2.5 | 1.0 | 5 | 10 | None |

*LN_T* number of harvested lymph nodes; *LN_P* number of positive lymph nodes; *SBD* soft-blended diet; *Hosp* hospital

[a] Median size of colon cancer: 5.0 cm; median number of harvested lymph nodes: 40

[b] Median size of liver metastases: 3.2 cm

[c] Median days of SBD intake: 5 days; median postoperative hospital stay 16 days

[d] Bleeding from the para-aortic node dissection site, liver cut-surface was clear

colorectal cancer with resultant morbidity and mortality rates of 9.8% and 0.4%, respectively. These experiences, and the current trend toward minimally invasive surgery, prompted us to develop a new laparoscopic-assisted combined surgical approach. Our first laparoscopic-assisted combined colon and liver resection was performed in September 2006. The long midline incision used before has recently been replaced by a small upper midline incision and several ports, with reduced abdominal wall morbidity and enhanced postoperative recovery.

We perform liver resections without the Pringle maneuver after colorectal resection and intestinal anastomosis as that maneuver may adversely affect the bowel anastomosis in terms of splanchnic blood flow congestion, visceral edema, and a significant decrease in mesenteric blood flow, which could culminate in intestinal ischemia

[15, 16]. The Pringle maneuver was not used in any of the 10 patients reported here, even for those undergoing major liver resection, and no anastomotic complications were encountered. The parenchymal transection using a standard open technique applied in the current patients avoids the risk of pneumoperitoneum-associated complications such as hemodynamic or cardiovascular problems or gas embolisms, which are most likely to occur at the parenchymal transection under the pneumoperitoneum [17, 18].

Hand-assisted laparoscopic surgery in which the surgeon's hand is inserted into the abdominal cavity to enable direct manipulation of the viscera is considered useful and safe for less invasive surgery [19, 20]. The hand is used for retraction and to assess tumor clearance.

In view of the size of the abdominal wound for specimen extraction, we limited this technique to minor liver resection and liver mobilization. The hand facilitates proper traction and exposure of the cut surface, and hemostasis can be achieved by correct application of vascular clips or staplers. The parenchymal transection is performed with a laparoscopic ultrasonic dissection device. Various liver resections using the hanging maneuver for safe parenchymal transection can be performed even through a smaller-than-usual upper midline incision because the parenchymal transection plane hanging tape guide is longitudinal and parallel to the IVC and upper midline incision, and is secured within the upper midline incision [14].

All 10 patients had grossly normal livers and good liver function. Normal livers, especially in slim patients whose perihepatic ligaments are relatively flexible and thin, can be easily retracted and mobilized through a gap even smaller than the upper midline incision used in the present study. A high level of coordination is required between the surgeon and the assistant in order to secure the surgical field, resect the liver, and control any inadvertent bleeding. While dissection between the liver and IVC, cholecystectomy, and hilar dissection can be performed laparoscopically, such procedures can be performed through the hand port incision using standard open techniques. Once the right or left liver is partially mobilized, the liver can be rotated to the right or left of the midline and retracted in this position while retrohepatic IVC dissection is performed under direct visualization using open techniques.

The minimum size of the abdominal incision can depend on the tumor size and the resected liver size. While almost all laparoscopic colorectal surgery is possible using an approximately 5-cm incision, the liver has a hard parenchyma and is much larger than other intra-abdominal organs. Although a small liver tumor can be totally resected laparoscopically and extracted through a small incision, an incision of at least 8–15 cm is required for retrieval of a major liver resection specimen. Fragmentation of the liver into smaller pieces in order to deliver it through a small incision would be unacceptable in oncologic surgery. Therefore, we postulated that if the abdomen must be opened to remove the resected specimen, it would be best to transect the liver parenchyma in advance using a standard open technique rather than a total laparoscopic approach. The upper midline incisions used were the minimum size required to retrieve the resected liver specimen even under entirely laparoscopic conditions.

The key and difficult point of this technique is mobilization of the liver, which can be achieved both from harmonious coordination between an operator and a first assistant and by adjusting the strength and direction of the retracting force on bilateral edges of the wound. We used an approximately 15-degree reverse Trendelenberg position and a standard adult Kent retractor frame (Takasago, Tokyo, Japan) to maximize the operative exposure (Fig. 2). Not until the lateral and upper ligamentous attachments are dissected does it become possible to dissect the liver from the inferior side because the liver can be easily retracted anteriorly.

The present report describes a laparoscopic-assisted combined colon and liver resection procedure for patients with primary colorectal cancer and synchronous liver metastases. The study showed that the approach was safe, and that the operative time was acceptable. Furthermore, our approach avoided the morbidity associated with open procedures which require a long right subcostal incision with muscular division, often extended to the left, the upper midline, or both. We believe that the small incision length used in the procedure resulted in less pain and enhanced postoperative recovery. Surgical techniques affect postoperative narcotic analgesic use [21], and small-intestine motility after colectomy correlates with the amount of narcotic analgesic used [22]. The present patients were administered narcotic analgesics for only 2 days postoperatively, and all patients were consuming a soft blended diet within a median 5 days (range: 4–7 days).

In conclusion, this study of 10 patients suggests that laparoscopic-assisted combined colon and liver resection may be a feasible and safe alternative for selected patients with primary colorectal cancer and synchronous liver metastases.

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