

The role of staging laparoscopy for intraabdominal cancers: an evidence-based review

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Abstract Diagnostic laparoscopy is minimally invasive surgery for the diagnosis of intraabdominal diseases. The aim of this review is a critical examination of the available literature on the role of laparoscopy for the staging of intraabdominal cancers. A systematic literature search of English-language articles on MEDLINE, the Cochrane database of evidence-based reviews, and the Database of Abstracts of Reviews of Effects was performed for the period 1995–2006. The level of evidence in the identified articles was graded. The search identified and reviewed seven main categories that have received attention in the literature: esophageal cancer, gastric cancer, pancreatic cancer, hepatocellular carcinoma, biliary tract cancer, colorectal cancer, and lymphoma. The indications, contraindications, risks, benefits, diagnostic accuracy of the procedure, and its associated morbidity are discussed. The limitations of the available literature are highlighted, and

evidence-based recommendations for the use of laparoscopy to stage intraabdominal cancers are provided.

Keywords Diagnostic laparoscopy · Intraabdominal cancer · Staging laparoscopy

Diagnostic laparoscopy is minimally invasive surgery for the diagnosis of intraabdominal diseases. The procedure enables direct inspection of large surface areas of intraabdominal organs; facilitates obtaining biopsy specimens, cultures and aspirates; allows the use of laparoscopic ultrasound; and makes therapeutic intervention possible.

Diagnostic laparoscopy has been applied to many clinical situations with variable success. Its application for the staging of intraabdominal cancers is known as staging laparoscopy (SL). This article aims to review and grade the available evidence (Table 1) on the role of SL for a variety of intraabdominal cancers.

To achieve our objective, a systematic literature search of English-language articles on MEDLINE, the Cochrane database of evidence-based reviews, and the Database of Abstracts of Reviews of Effects (DARE) was performed for the period 1995–2006. A detailed description of this method has been published previously [1]. This review addresses seven main categories identified and reviewed in the literature: esophageal cancer, gastric cancer, pancreatic cancer, hepatocellular carcinoma, biliary tract cancer, colorectal cancer, and lymphoma.

Staging laparoscopy for esophageal cancer

Patients with esophageal cancer often present with an advanced stage with lymph-node or even distant

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Table 1 Levels of evidence

Level 1	Evidence from properly conducted randomized, controlled trials
Level 2	Evidence from controlled trials without randomization Cohort or case-control studies Multiple time series dramatic uncontrolled experiments
Level 3	Descriptive case series, opinions of expert panels

metastases. For this reason, the overall prognosis for patients with esophageal cancer is poor.

Patients with advanced cancer commonly undergo preoperative chemotherapy and radiation in an attempt to improve survival. Thus, the value of precise staging is important to separate patients with an early-stage tumor who are candidates for immediate curative resection from those who need neoadjuvant therapy. The most common radiologic tests used to confirm the stage of the tumor are computed tomography (CT) scan, endoscopic ultrasound, and positron emission tomography (PET) scan. Staging laparoscopy may aid in more accurate staging of esophageal cancers to guide the most appropriate treatment and avoid nontherapeutic laparotomy.

Staging laparoscopy is most commonly performed with the patient under general anesthesia in supine position. After pneumoperitoneum has been safely established, an angled laparoscope placed through an umbilical port site is recommended for optimal visualization. Additional ports in the left upper quadrant and epigastric area can be placed as needed for tissue manipulation.

Full inspection of the peritoneal cavity is performed to evaluate for peritoneal or liver metastases. If no distant disease is discovered initially, then the left lateral lobe of the liver is elevated to expose the gastroesophageal junction with the patient placed in steep reverse Trendelenburg position. The tumor is inspected for extension into the surrounding area. Biopsies can be performed for lymph nodes in the gastrohepatic ligament or celiac axis suspected to be malignant. An optional laparoscopic feeding jejunostomy may be placed if neoadjuvant therapy is planned.

In addition, combined thoracoscopic/laparoscopic staging has been described to improve staging for esophageal cancer by increasing the number of positive lymph nodes identified compared with conventional staging [2]. Specifically for the thoracoscopic evaluation, the patient is in full, left lateral decubitus position with single-lung ventilation. Two to three thoracic trocars are placed, and the mediastinal pleura overlying the esophagus is incised to identify lymph nodes and to perform biopsies for them as needed.

Staging laparoscopy should be used for patients with esophageal cancer who are potential candidates for curative surgical resection based on preoperative staging showing

no evidence of lymph node or distant metastases. Furthermore, the procedure can be used to place enteral feeding access for patients who are candidates for neoadjuvant therapy, particularly if percutaneous endoscopic gastrostomy is not feasible. In contrast, SL is contraindicated for patients with known metastatic disease. In addition, dense intraabdominal adhesions from prior surgery, particularly in the upper abdomen, may preclude successful laparoscopy.

Because patients with distant or lymph node metastasis are best treated with chemotherapy and radiation as neoadjuvant therapy or even palliation, SL can potentially decrease the time to this adjuvant treatment. The average length of hospital stay after SL typically is only 1–3 days, which compares favorably with that for open exploration. Subsequently, this faster postoperative recovery may lead to a shortened interval to the appropriate therapy. However, this assumed benefit of earlier adjuvant therapy for patients with metastatic disease has not been measured specifically in the literature.

Complications after SL for esophageal cancer are low, and no mortality has been reported. Potential complications include bleeding, infection, esophageal injury during inspection, and the general risks associated with anesthesia. One report documented perforation at the feeding jejunostomy tube site as well as pulmonary edema due to unexpected aortic valve stenosis [3]. False-negative diagnostic laparoscopy can potentially lead to unnecessary laparotomy. No adverse oncologic effects of SL for esophageal cancer have been reported.

When all preoperative imaging indicates no metastatic disease, SL with or without laparoscopic ultrasound has a sensitivity of 71% for finding peritoneal metastases, 78% for finding nodal metastases, and 86% for finding liver metastases (level 2 evidence) [4]. This compares with respective ultrasound sensitivities of 14, 11, and 86% and CT scan sensitivities of 14, 55, and 71% (level 2 evidence) [4]. The accuracy is reported to be 75–80% (level 3 evidence) [3]. However, several reports indicate that only 0.08–10% of patients actually had a change in their management based on the results of laparoscopy (levels 2 and 3 evidence) [4, 5].

In the hands of a skilled thoracic surgeon, combined thoracoscopic and laparoscopic staging can be performed more than 70% of the time [2]. Compared with final pathologic staging, thoracoscopic and laparoscopic staging has a sensitivity of 64%, a specificity of 60%, and an accuracy of 60% (level 2 evidence) [6].

The available literature has limitations with regard to SL for esophageal cancer, and no level 1 evidence exists. A small number of reports have been published by highly specialized centers, which may make the reproducibility of their results difficult. In addition, studies differ in their

technique and intended hypotheses. The impact of the surgeon's expertise on the diagnostic accuracy of the procedure is unknown. Thus, the overall analysis of SL for esophageal cancer is difficult given the inconsistency of the reported data.

Summary of SL for esophageal cancer

Based upon our review of the literature, diagnostic laparoscopy for staging can be performed safely for patients with esophageal cancer. Patients considered to be candidates for curative resection (with early-stage esophageal cancer and no evidence for distant or lymph node metastases on high-quality preoperative imaging) may benefit from SL. Laparoscopy also provides the opportunity for enteral feeding tube placement without the need for laparotomy. The procedure also may facilitate a shorter time to adjuvant therapy initiation than laparotomy, but data are limited, and additional research is needed to elucidate the true value of diagnostic laparoscopy in this setting.

Staging laparoscopy for gastric cancer

Because many patients with gastric cancer present with locally advanced or metastatic disease, accurate staging of gastric cancer aids in the appropriate treatment selection for both cure and palliation. Palliative resection may be indicated for gastric cancer causing obstruction, hemorrhage, or perforation. However, surgical resection alone for patients with advanced disease has not been shown to improve survival.

Studies investigating neoadjuvant protocols for locally advanced gastric cancers are ongoing, which makes accurate staging imperative. Moreover, even after many preoperative radiologic tests (CT scan, endoscopic and transabdominal ultrasound, and PET scan) for staging of gastric tumors, a proportion of patients are found at exploration to have unsuspected, unresectable disease. Thus, SL may aid in more accurate staging of gastric cancers and guide appropriate treatment without the morbidity associated with exploratory laparotomy.

The SL procedure is most commonly performed with the patient under general anesthesia in the supine position. After safe establishment of pneumoperitoneum, an angled laparoscope typically is inserted through an umbilical port site. If present, ascites can be aspirated and sent for cytology. In the absence of ascites, 200 ml of normal saline can be instilled into the peritoneal cavity and aspirated from the pelvis and bilateral subdiaphragmatic spaces for cytologic examination [7]. Full inspection of the peritoneal cavity is performed to evaluate for peritoneal or liver metastases. Laparoscopic ultrasound may aid in the detection of deep hepatic lesions.

If no metastatic disease is discovered, then the left lateral lobe of the liver is elevated to expose the entire stomach. The perigastric nodes along the greater and lesser curvature are inspected, and biopsies are performed if necessary. In addition, the porta hepatis and gastrohepatic ligaments are inspected carefully. Next, the gastric tumor itself is inspected for extraserosal invasion and infiltration into surrounding structures. If the tumor is posterior, then the lesser sac must be accessed to gain appropriate visualization.

Staging laparoscopy is indicated for patients who have T3 or T4 gastric cancer without evidence of lymph node or distant metastases on high-quality preoperative imaging. Accurate preoperative staging determines the most appropriate therapy for gastric cancer. Staging laparoscopy can identify patients with locally advanced disease and metastasis that may be treated best with neoadjuvant or palliative chemotherapy rather than surgical resection. These patients may potentially be spared the risks and complications of a nontherapeutic laparotomy and may have a shorter convalescence period with an earlier start of chemotherapy.

Staging laparoscopy should not be undertaken for patients with gastric cancer complicated by obstruction, hemorrhage, or perforation in need of palliative surgery. In addition, patients with early-stage gastric cancer (T1 or T2) should proceed directly to surgical resection without SL.

Complications of SL with gastric cancer tend to be rare and include bleeding, infection, and visceral injury. No mortality has been reported. Although no direct comparisons have been made between SL and exploratory laparotomy for gastric cancer staging, the average length of hospital stay after SL is reported to be 1 to 2 days, which compares favorably with stays after exploratory laparotomy for other indications [8, 9]. No adverse oncologic effects of SL for gastric cancer have been reported.

Staging laparoscopy can identify unsuspected metastatic disease in 13% to 57% of patients despite negative preoperative imaging studies (levels 2 and 3 evidence) [7, 10–14]. Accuracy is reported to range from 89% to 100% in different series (levels 2 and 3 evidence) [7, 11–15]. In addition, exploratory laparotomy has been avoided in 17–40% of cases (levels 2 and 3 evidence) [7, 8, 13–15]. The SL procedure is more sensitive (96%) for detecting hepatic metastasis than either CT (52%) or ultrasound (37%) (level 3 evidence) [15]. Similarly, SL sensitivity also is better for detecting peritoneal metastasis (laparoscopy, 69%; ultrasound, 23%; CT, 8%) (level 3 evidence) [15].

The additional value of laparoscopic ultrasound has not yet been determined. Peritoneal washings positive for cancer cells have been demonstrated to correlate with the extent of disease (T1/T2, 0%; T3/T4, 10%; and M+, 59%) (level 3 evidence) [16].

The quality of the available literature on SL for gastric cancer is limited because no level 1 evidence exists. In addition, studies differ in their technique and use of laparoscopic ultrasound and peritoneal washings. Many reports do not clearly state preoperative imaging or postoperative pathology. The impact of the surgeon's expertise on the diagnostic accuracy of the procedure also is unknown. The reported data are not consistent across studies, making their analysis difficult.

Summary of SL for gastric cancer

Based on our review of the literature, SL can be performed safely for patients with gastric cancer. The procedure should be considered for patients with T3 or T4 tumors who are thought to have localized or locally advanced disease according to high-quality preoperative imaging. In contrast, the procedure has a very low yield for patients with early-stage disease (T1 or T2) and therefore is not necessary for this patient population.

Staging laparoscopy for pancreatic cancer

Pancreatic cancer has a dismal overall 5-year survival rate (<5%), and most patients have inoperable disease at diagnosis. Even after aggressive preoperative imaging, many patients are found to have unresectable disease during laparotomy. Staging laparoscopy may benefit patients with pancreatic adenocarcinoma by sparing those with imaging-occult incurable disease the morbidity, inconvenience, and expense of a nontherapeutic operation. In addition, it may lead to better selection of palliative treatments for patients with locally advanced disease.

The procedure is performed with the patient under general anesthesia using initial access near the umbilicus. Additional ports are placed as necessary to complete a thorough evaluation of peritoneal surfaces including the suprahepatic and infrahepatic spaces, surface of the bowel, lesser sac, root of the transverse mesocolon and small bowel mesentery, ligament of Treitz, paracolic gutters, and pelvis. Often, frequent bed position changes are necessary for full visualization of the aforementioned areas.

In addition to visual inspection, peritoneal washings can be performed, ascitic fluid can be sent for cytology, and biopsies of suspicious lesions can be obtained. When no metastatic disease is identified with inspection, a detailed laparoscopic ultrasound examination may be used to evaluate the deep hepatic parenchyma, portal vein, mesenteric vessels, celiac trunk, hepatic artery, entire pancreas, and even periportal and paraaortic lymph nodes. The addition of color flow Doppler can further assist in the assessment of vascular patency.

The extent of inspection during SL for pancreatic adenocarcinoma has been controversial. Advocates of a short-duration procedure based only on inspection of abdominal organ surfaces argue that the procedure can be performed quickly (usually within 10–20 min), requires only one port, does not require significant expertise, minimizes the risk of potential complications from dissection near vascular structures, and has good diagnostic accuracy [17, 18].

Conversely, advocates of a more extensive procedure that includes opening of the lesser sac and assessment of the vessels argue that the diagnostic accuracy of the procedure can be enhanced by detection of metastatic lesions in the lesser sac, vascular invasion by the tumor, or deep hepatic metastasis, which often are missed by visual inspection alone. They further insist that it can be performed safely without a significant increase in morbidity and within a reasonable time [19–21]. It is very important, therefore, to consider these differences in technique during evaluation of reports on the diagnostic yield of SL for patients with pancreatic adenocarcinoma.

The primary indication for SL is imaging-occult metastatic pancreatic adenocarcinoma or unsuspected locally advanced disease detected in patients with resectable disease based on preoperative imaging. Other indications include assessment of disease extent before administration of neoadjuvant chemoradiation as well as selection of palliative treatments for patients with locally advanced disease. However, SL should not be performed for patients with known metastatic disease. Dense adhesions that impair visual inspection may compromise the diagnostic yield of the procedure.

Procedure-related morbidity is reported to range from 0% to 4% [17–46]. Most complications are minor and include wound infections, port-site bleeding, or subcutaneous emphysema. Nevertheless, major complications such as myocardial infarction, pulmonary embolism, and intestinal or vascular injury have been described. The majority of the literature reports mortality rates of 0% [17–46]. However, at least one death has been reported due to a missed colonic injury during the procedure.

Conversions to open surgery are uncommon and in one large series were reported to occur for less than 2% of the patients [21]. The hospital length of stay after SL is reported to range from 1 to 4 days [39]. Evidence suggests that the hospital stay is shorter after laparoscopic staging than after open staging for pancreatic cancer patients [26]. For patients with locally advanced disease, SL is reportedly superior to exploratory laparotomy because it decreases length of hospital stay, increases the number of patients who receive chemotherapy, and shortens the time to initiation of such treatment [34, 47].

With regard to oncologic safety, initial concerns for port-site recurrence after laparoscopic procedures for

cancer patients have not been substantiated. Multiple studies report a 0–2% incidence of port-site recurrences after SL, which is similar to that after open explorations for cancer patients [24, 39, 47]. In one study of 235 patients comparing exploratory laparotomy with SL, laparoscopy was not associated with increased port-site recurrences or peritoneal disease progression [47]. Furthermore, evidence from the Surveillance Epidemiology and End Results (SEER) database suggests no survival differences between pancreatic cancer patients who underwent a laparoscopic procedure and those who had open surgery [48].

For detecting imaging-occult unresectable pancreatic adenocarcinoma, the literature reports that SL has a median sensitivity of 94% (range, 93–100%), a median specificity of 88% (range, 80–100%), and a median accuracy of 89% (range, 87–98%) (levels 2 and 3 evidence) [18–39]. However, the procedure misses 6% (range, 5–25%) of patients whose disease is identified as unresectable during an ensuing laparotomy (levels 2 and 3 evidence) [18–39].

Overall, 4% to 36% of patients can potentially avoid a nontherapeutic laparotomy (levels 2 and 3 evidence) [18–39]. A number of studies also have evaluated the added benefit of laparoscopic ultrasound at the time of laparoscopic staging. These studies indicate that the diagnostic accuracy of the procedure can be improved by 12–14% (levels 2 and 3 evidence) [19–24, 35–38].

Peritoneal washings are reported to augment the yield of the procedure. Reports on the sensitivity of peritoneal washings have ranged widely from 25% to 100% [18, 33, 40–42]. The highest sensitivity for peritoneal cytology is reported for patients with a disrupted ventral pancreatic margin, in which case, peripancreatic fatty tissue cannot be differentiated from the tumor by helical CT scan (level 3 evidence) [42].

In addition, locally advanced pancreatic cancers have a higher incidence of positive cytology (level 3 evidence) [28, 33, 43]. Furthermore, studies have shown a 7–14% incidence of positive peritoneal washings if no other metastatic disease is found during preoperative imaging and SL (level 3 evidence) [18, 33]. This incidence seems to be lower in studies that include a variety of periaampullary tumors (level 2 evidence) [30].

The diagnostic yield of the procedure also depends on the histology, stage of disease, tumor size, and location. There is convincing evidence that the yield of SL is significantly higher for patients with pancreatic cancer than for those with types of periaampullary tumors (level 3 evidence) [27, 28, 32, 39]. Furthermore, SL also appears to have a higher yield for patients with locally advanced cancer than for patients with localized disease. Identification of metastatic disease by SL for patients with locally advanced disease detected by high-quality imaging studies is reported in 34–37% of cases, which compares favorably

with the identification rates for metastatic disease among patients with localized disease (level 3 evidence) [17, 43, 44].

Tumors of the pancreas body and tail are associated with a higher likelihood for unsuspected metastasis found at laparoscopy (level 3 evidence) [18, 33]. Larger tumors appear to be associated with a higher incidence of imaging-occult metastatic disease (level 3 evidence) [28, 39, 45, 46]. Although the tumor size at which the risk of occult M1 disease justifies the added time and cost of laparoscopy is currently unknown, some studies suggest that tumors larger than 3 cm are more likely to be associated with metastatic disease at exploration (level 3 evidence) [45, 46]. Moreover, a CA 19–9 level lower than 150 has been associated with a lower likelihood for metastatic disease and consequently a lower yield for SL (level 3 evidence) [49].

Although high-quality evidence on the cost effectiveness of SL is lacking, the literature suggests that SL is more cost effective than open exploration when it is the only procedure required (i.e., for patients with unsuspected metastatic disease identified during SL) (level 2 evidence) [50]. This is a consequence of decreased patient length of hospital stay. On the other hand, the cost effectiveness of SL when applied in the diagnostic algorithm of all pancreatic cancer patients appears linked directly to the yield of the procedure in identifying patients with imaging-occult disease. In a cost utility analysis of the most effective management strategy for pancreatic cancer patients, at least a 30% yield was needed for SL to be more cost effective than open exploration (level 3 evidence) [51].

The quality of the available studies on SL for patients with pancreas cancer is limited. No level 1 evidence exists. Furthermore, population-based data are very limited because the majority of studies are single-institution reports from highly specialized centers, making generalizations difficult and allowing institutional and personal biases to be introduced into the results. In addition, reported data are not uniform across studies, making their analysis difficult. A number of studies assess the role of laparoscopy indirectly without performance of a single laparoscopic staging procedure (referred to as “phantom” studies by some authors). These studies assume that only visible metastatic disease would have been detected at the time of laparoscopy, ignoring the value of laparoscopic ultrasound and cytology.

Other studies do not clearly report the quality of preoperative imaging, the criteria used to define resectability, or the number of R0 resections. Furthermore, studies often evaluate nonhomogeneous patient samples, including patients with localized and locally advanced pancreatic cancers as well as patients with periaampullary and other nonpancreatic cancers or even benign disease and do not report results separately.

Summary of SL for pancreatic cancer

Based on our review of the literature, SL can be performed safely and effectively for patients with pancreatic adenocarcinoma. The procedure should be considered after high-quality imaging studies have excluded metastatic disease for appropriately selected patients with either localized or locally advanced pancreatic adenocarcinoma. The use of laparoscopic ultrasound and peritoneal washings is encouraged because they may improve the diagnostic accuracy of the procedure. Based on the available evidence, selective rather than routine use of the procedure may be better justified and more cost effective for those with larger tumors; tumors involving the pancreatic neck, body, or tail; and patients with clinical, laboratory, or imaging findings suggestive of more advanced disease. Nevertheless, the effectiveness of such selection criteria needs to be verified by additional prospective studies.

Staging laparoscopy for hepatocellular carcinoma

The prognosis of patients with hepatocellular carcinoma may be improved with the appropriate selection of treatment based on extent of disease. Subsequently, accurate identification of all hepatic lesions including size, number, and location is critical to therapy. Because peritoneal disease is uncommon with hepatocellular carcinoma, inspection of peritoneal surfaces with diagnostic laparoscopy alone tends to be less valuable than SL with laparoscopic ultrasound. The appropriate identification of patients who have unresectable disease using SL with laparoscopic ultrasound not only will spare these patients a nontherapeutic laparotomy with its associated morbidity, but also may alter treatment plans. Additional benefits include decreased patient morbidity, hospital stay, and costs, as well as earlier adjuvant treatment. A 60% drop in hospital charges for patients undergoing SL compared with open laparotomy patients has been described for this population [52].

Staging laparoscopy generally is performed with the patient under general anesthesia in the supine position. After establishment of pneumoperitoneum, an angled laparoscope through an umbilical port is recommended for optimal visualization of the entire liver. Additional ports can be placed in the right anterior axillary line and epigastric area as needed. A standard laparoscopic ultrasound probe is used for systematic examination of the entire liver to identify all lesions suspected to be malignant. Ultrasound-guided core biopsy should be used for suspicious lesions that are unresectable or preclude curative resection. Biopsy of resectable lesions need not be performed.

Patients with primary hepatic tumors whose proposed curative resection is based on preoperative identification of disease size and location with adequate hepatic reserve are the best candidates for SL. Conversely, known unresectable hepatic disease such as major vessel or organ invasion would be a contraindication for SL. In addition, patients with dense intraabdominal adhesions, particularly surrounding the liver, from prior surgery may not be ideal candidates for SL and laparoscopic ultrasound.

Procedure-related complications are uncommon, and no mortality has been reported. Bleeding, infection, bowel injury, bile leak, and anesthesia-related complications may occur. Compared with open exploration, patients undergoing SL with laparoscopic ultrasound are reported to have a shorter hospital stay (9 vs. 2.2–5 days, respectively) and earlier adjuvant therapy (within 23 vs. 6 days, respectively) (levels 2 and 3 evidence) [52, 53]. No adverse oncologic effects of the procedure have been described.

For identifying hepatic tumors using, triphasic CT scan is less sensitive than laparoscopic ultrasound in correlation studies and highly dependent on tumor size, with detection rates of 71% for tumors size 0–1 cm, 84% for tumors size 1–2 cm, 96% for tumors size 2–3 cm, and 100% for tumors larger than 3 cm (100%) (level 2 evidence) [54]. Laparoscopic ultrasound can detect 9.5% more tumors (most smaller in size than 1 cm) than CT alone (level 2 evidence) [54]. Staging laparoscopy correctly identifies 63% to 67% of patients with unresectable disease (levels 2 and 3 evidence) [52, 53]. Unresectable disease was most commonly missed by SL because of vascular invasion, lymph node metastases, and adjacent organ invasion. With the combination of SL and laparoscopic ultrasound, 16% to 25% of patients may avoid open laparotomy (levels 2 and 3 evidence) [52, 53].

The quality and amount of the available literature on SL for primary hepatic tumors are limited, and no level 1 evidence exists. The designs of these studies differ. Some compare combined SL and laparoscopic ultrasound with preoperative imaging, whereas others compare it with exploratory laparotomy. There also is inconsistency in the type of preoperative imaging and the specific CT scan techniques used. In addition, the impact of each surgeon's expertise with laparoscopic ultrasound on the diagnostic accuracy of the procedure remains unknown. These limitations make firm recommendations difficult.

Summary of SL for hepatocellular carcinoma

Based on our review of the literature, SL with laparoscopic ultrasound can be performed safely for patients with primary hepatic tumors or hepatocellular carcinoma. Patients with primary hepatic cancers that appear resectable on preoperative imaging may benefit from SL with

laparoscopic ultrasound used to evaluate extent, location, and size of disease. Results of SL have the potential to alter treatment appropriate to the extent of disease. Selection criteria that may increase the yield and cost effectiveness of the procedure still need to be determined, and further studies are needed.

Staging laparoscopy for biliary tract tumors

Biliary tract tumors can be divided into two main categories: gallbladder cancers and cholangiocarcinomas. The two groups differ in their patterns of spread and their prognoses. Gallbladder cancer tends to grow more rapidly, with earlier dissemination, which makes SL a more useful tool in this setting. In contrast, cholangiocarcinomas tend to be more locally invasive, decreasing the yield of SL. Preoperative imaging to determine resectability of all biliary tract cancers often includes ultrasound, CT scan, direct cholangiography (percutaneous transhepatic cholangiography or endoscopic retrograde cholangiopancreatography), and/or magnetic resonance cholangiopancreatography. These radiologic preoperative studies are used to evaluate the extent of tumor within the biliary tree, vascular invasion, hepatic lobar atrophy, and metastatic disease. The goal of SL would be to spare patients from a laparotomy for incurable disease and to offer the associated benefits of decreased morbidity and pain, faster recovery, and earlier adjuvant treatment. Notably, however, many gallbladder cancers are incidental findings during or after laparoscopic cholecystectomy. Thus, for patients with gallbladder cancers found after cholecystectomy, liver resection is indicated as a secondary procedure, thereby obviating the need for SL.

Typically, SL is performed with the patient under general anesthesia in the supine position. After establishment of pneumoperitoneum, an angled laparoscope through an umbilical port is recommended for optimal visualization of the entire abdominal cavity. Additional ports can be placed in the right anterior axillary line and epigastric area as needed. Careful and thorough inspection of the peritoneum, pelvis, liver surfaces, porta hepatis, gastrohepatic ligament, and omentum should be performed. A standard laparoscopic ultrasound probe may improve the yield of lesions found in the liver as well as lymph node metastasis found in the porta hepatis and celiac nodal areas. Biopsy specimens of peritoneal metastases, nodes suspected to be malignant, and hepatic lesions should be obtained to determine the extent of disease.

The indications for the use of SL to detect biliary tract tumors differ slightly depending on the origin of the cancer. For gallbladder cancer, SL generally is indicated for patients with known or suspected gallbladder cancer but no evidence of unresectable or metastatic disease unless noted

as an incidental finding after cholecystectomy. With cholangiocarcinomas, SL is indicated for stage T2 or T3 hilar cholangiocarcinoma without evidence of unresectable or metastatic disease determined by preoperative imaging. Alternatively, SL is contraindicated for known metastatic or unresectable disease and known stage T1 disease found incidentally for gallbladder cancer. Dense intraabdominal adhesions from prior surgery, particularly surrounding the porta hepatis, may be considered a relative contraindication.

The reported incidence of complications is low, with no mortality. Potential risks include bleeding, infection, and bile leak, particularly if liver biopsy is performed. Additional risks include those associated with surgical laparoscopy in general and those associated with anesthesia. The assumed benefit of earlier adjuvant therapy for patients with metastatic disease has not been addressed in the literature. However, the average length of hospital stay after SL is 2 to 3 days, which compares favorably with laparotomy (level 2 evidence) [55, 56]. There have been no reported adverse oncologic effects of SL for biliary cancer.

Staging laparoscopy can add further information to standard preoperative imaging by identifying peritoneal or superficial liver metastases (23%), which often are not detected with radiology (level 3 evidence) [57]. For gallbladder cancer, the overall yield for unresectable disease found with SL is reported to be 48%, with a diagnostic accuracy of 58% (level 2 evidence) [55]. For cholangiocarcinoma, as many as 9–42% [56–58] of patients may avoid laparotomy with an accuracy of 42–53% (levels 2 and 3 evidence) [58]. For detecting unresectable disease, SL has a reported sensitivity of 60% and a negative predictive value of 52% (level 2 evidence) [56].

The yield of SL for gallbladder cancer is slightly higher than for cancers of the biliary tree due to the higher incidence of peritoneal and liver metastases associated with gallbladder cancer. One study suggests that the yield for cholangiocarcinoma may be improved if SL is limited to patients with higher-stage primary tumors on preoperative imaging (T2 and T3) because few patients with stage T1 disease are deemed unresectable by laparoscopy (9%) [55]. The added benefit that laparoscopic ultrasound improves the diagnostic yield of the procedure has been inconsistent in the literature (0–41%) (levels 2 and 3 evidence) [57, 58].

The reported literature on SL used for biliary tract cancer patients is limited, and no level 1 evidence exists. A small number of reports describe highly specialized centers with variations in technique. In addition, some studies span a period of 7–10 years, which likely affects the quality of preoperative imaging and laparoscopic technique at the beginning and end of the study. The impact of the surgeon's expertise on the diagnostic accuracy of the procedure is unknown. These shortcomings of the literature limit our ability to provide strong recommendations.

Summary of SL for biliary tract cancers

Based upon our review of the literature, SL can be performed safely for patients with cancers of the biliary tract and gallbladder. Staging laparoscopy may be used for suspected gallbladder cancers believed to be resectable by preoperative, high-quality imaging studies. However, SL generally is not used for patients in whom an incidental gallbladder cancer was identified after cholecystectomy. Patients with biliary tract cancers or cholangiocarcinomas also may benefit from SL through the identification of imaging-occult disease in the peritoneum, the lymph nodes, or the liver itself. The benefit of the procedure may be maximized for patients with locally advanced cholangiocarcinoma (stage T2 and T3) because the yield of the procedure with this patient population is higher. Laparoscopic ultrasound may improve the yield of the procedure. However, additional data are needed.

Staging laparoscopy for colorectal cancer

In the primary treatment of colorectal cancer, SL seldom is used because surgical resection and palliation typically are indicated to prevent bleeding, obstruction, and perforation even in patients with advanced disease. However, patients who have liver metastases from a primary colorectal cancer may be candidates for curative resection when no other extrahepatic disease exists and when all the disease in the liver is resectable. Thus, for these patients, SL can provide more accurate identification of all hepatic lesions than noninvasive imaging including size, number, and location.

Similar to SL for primary hepatic tumors, SL and laparoscopic ultrasound can identify patients with unsuspected extrahepatic metastatic disease. The identification of these patients may spare them the morbidity of a nontherapeutic open laparotomy and may alter treatment plans. As with other intraabdominal cancers, SL may lead to lower hospital costs, shorter length of stay, and earlier adjuvant therapy than open exploration without resection.

The technique is similar to SL in other settings. The patient is placed in the supine position, and pneumoperitoneum is established. An angled laparoscope through an umbilical port is recommended for optimal visualization of the entire abdominal cavity. Additional ports can be placed as needed. A standard laparoscopic ultrasound probe often is used for systematic examination of the entire liver to identify all lesions suspected to be malignant. The ultrasound examination also should include the porta hepatis and celiac lymph nodes. Ultrasound-guided biopsy of peritoneal, lymph node, and unsuspected liver lesions should be obtained.

The primary indication of SL in this population is resectable liver metastases from colorectal cancer without concomitant evidence of extrahepatic metastatic disease on noninvasive imaging. Conversely, patients with known extrahepatic metastatic disease or unresectable hepatic disease should not undergo SL. Dense intraabdominal adhesions from prior surgery, particularly surrounding the liver, may preclude adequate examination and thorough SL.

In general, the morbidity and mortality for SL in these patients are low, and the complications include bleeding, infection, bowel injury, bile leak, and other complications associated with laparoscopy. However, complications are reported to be as high as 28%, including pneumonia and myocardial infarction [59]. The hospital length of stay is demonstrated to be significantly shorter for SL (1.2 days) than for open laparotomy (5.8 days) [60]. A 55% reduction in total hospital charges, with the greatest savings in room and board charges, has been reported with SL compared with open exploration (level 2 evidence) [60]. No adverse oncologic effects have been described.

Studies comparing open intraoperative ultrasound with laparoscopic ultrasound and preoperative CT scanning for colorectal metastases have shown that the yield is best with open intraoperative ultrasound, followed by laparoscopic ultrasound (98% yield; one detected lesion less than with open intraoperative ultrasound) and CT scan (78% yield) [61]. Furthermore, SL and laparoscopic ultrasound have better sensitivity than noninvasive imaging studies for the detection of nodal metastases (94% for laparoscopic ultrasound vs 18% for preoperative imaging) [62]. The combination of SL and laparoscopic ultrasound is reported to detect unresectable disease in 25–42% of patients for whom preoperative radiologic testing showed potentially curable disease [59, 60]. The use of laparoscopic ultrasound can further identify unresectable disease, which may not be seen with laparoscopic inspection alone [60]. In addition, the findings of the procedure have altered the management for 33% to 48% of patients [59, 62, 63].

The Clinical Risk Score (CRS) system was developed to predict which patients will most likely benefit from SL. This system uses five preoperative criteria, which are independent factors of prognosis: (1) lymph node-positive colon cancer, (2) disease-free interval shorter than 12 months (time from discovery of primary colon cancer to discovery of liver metastases), (3) more than one hepatic tumor, (4) carcinoembryonic antigen greater than 200 ng/ml within 1 month after surgery, and (5) size of largest hepatic tumor greater than 5 cm. Each factor is assigned one point. If the CRS is greater than 2, then the yield of SL is higher [60].

The quality and amount of the available literature on SL for colorectal cancer liver metastasis is limited because no

level 1 evidence exists. Although most studies use laparoscopic ultrasound to establish resectability, institutions differ in their technique and expertise. The impact of the surgeon's expertise on the diagnostic accuracy of the procedure is unknown. The limited available evidence impairs our ability to provide firm recommendations.

Summary of SL for colorectal cancers

Based upon our review of the literature, SL can be performed safely for patients with hepatic metastasis of colorectal cancer. Patients with isolated colorectal hepatic metastases who are candidates for liver resection may benefit from SL with laparoscopic ultrasound. The patients most likely to benefit from this procedure are those who have more than two poor outcome factors as described by the CRS.

Staging laparoscopy for lymphoma

Hodgkin's lymphoma originates in one nodal group and spreads in a stepwise manner to contiguous nodal groups. Staging laparoscopy may be useful in determining the stage and location of the disease, and this may affect decisions regarding treatment, particularly the administration of chemotherapy. In contrast, for non-Hodgkin's lymphoma, the exact extent of the disease has less impact on the treatment course, so SL is less frequently performed in cases of non-Hodgkin's lymphoma. Staging laparoscopy may spare patients the morbidity of a laparotomy and provide tissue to confirm the diagnosis of non-Hodgkin's lymphoma or allow the surgical staging of Hodgkin's lymphoma. Staging laparoscopy also can be used for patients who need laparoscopic splenectomy as treatment and may lead to less pain, faster recovery, and earlier definitive treatment.

The technique of SL for lymphoma tends to be more involved than SL for simple inspection of the peritoneal surfaces with other cancers. Patients are commonly placed at a 45° angle in the left decubitus position. A laparoscopic hand-assisted technique may be used, especially when splenectomy is planned. The steps of SL are similar to those used in the traditional open procedure including inspection for gross abnormalities; core liver biopsy of each hepatic lobe and wedge biopsy of left lateral liver segment; laparoscopic ultrasound to search for hepatic lesions; splenectomy with removal of the organ intact; lymph node sampling of the iliac, celiac, portal, mesenteric, and periaortic areas; lymph node excision of abnormal nodes identified at preoperative testing with application of clips in those excision areas; and oophoropexy posterior to the uterus.

The primary indication for SL in non-Hodgkin's lymphoma is a tissue diagnosis through biopsy of

intraabdominal lymph nodes in the absence of peripheral lymphadenopathy, particularly when percutaneous core needle biopsy has been nondiagnostic. In addition, SL can be used for accurate staging of Hodgkin's lymphoma when staging affects decisions for appropriate treatment or prognosis. Staging laparoscopy also may be indicated for restaging after treatment or when recurrence is suspected.

Published morbidity rates range widely (1–20%) and include complications such as small bowel perforation, abscess, pancreatitis, bleeding, and pneumonia [64–66]. Conversion to laparotomy is reported to occur in 5–17% of the cases. No mortality has been reported [64–66]. The presumed benefit of earlier adjuvant therapy has not been addressed in the literature, but length of hospital stay after diagnostic laparoscopy is reported to vary from 1 to 4 days [64, 65]. No adverse oncologic effects from the procedure have been reported.

Data on the accuracy of the procedure come mainly from feasibility studies and are sparse. Compared with percutaneous biopsy, laparoscopic biopsy is demonstrated to have superior sensitivity (87% vs. 100%), specificity (93% vs. 100%), and accuracy (33% vs. 83%) (level 3 evidence) [64].

The quality of the available literature on SL for lymphoma is primarily limited to retrospective reviews. In addition, the number of available studies is quite small. Furthermore, some studies compare the accuracy of the procedure with that of historical controls for open surgery, which increases the bias of the results. Surgical technique differs according to institution and surgeon experience, making generalizations difficult and strong recommendations impossible.

Summary of SL for lymphomas

Based on our review of the literature, SL for lymphoproliferative disorders is safe and effective. The best indication for SL in lymphoproliferative disorders may be a tissue diagnosis of non-Hodgkin's lymphoma when core needle biopsy is nondiagnostic. In addition, SL is indicated for primary staging or even restaging of Hodgkin's lymphoma when accurate staging affects decisions for appropriate treatment and prognosis. Furthermore, laparoscopy may be performed when splenectomy is required in this patient population.

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