Published in final edited form as:

Ann Surg Oncol. 2017 May ; 24(5): 1174–1179. doi:10.1245/s10434-016-5757-3.

Percutaneous Peritoneal Lavage for the Rapid Staging of Gastric and Pancreatic Cancer

Linda M. Pak, MD, Daniel G. Coit, MD, Anne A. Eaton, MS, Peter J. Allen, MD, Michael I. D'Angelica, MD, Ronald P. DeMatteo, MD, William R. Jarnagin, MD, Vivian E. Strong, MD, and T. Peter Kingham, MD

Abstract

Background—Positive peritoneal cytology (PC) is classified as M1 disease in gastric and pancreatic cancer. While PC is typically obtained by laparoscopic peritoneal lavage (PL), this study sought to examine the feasibility and safety of performing this percutaneously, with monitored anesthesia care and in combination with other diagnostic procedures to condense and expedite the staging process.

Methods—Patients with gastric or pancreatic cancer scheduled for laparoscopy with PL were prospectively enrolled to undergo intraoperative percutaneous PL prior to laparoscopic PL. Saline was infused through a percutaneously-inserted catheter and fluid was collected for PC. Three-quadrant washings collected during laparoscopy were also sent for PC. The primary outcome was to evaluate the sensitivity and specificity of percutaneous PL for detecting positive PC compared with the gold standard of laparoscopic PL. The secondary outcome was to determine safety.

Results—Percutaneous PL was successfully performed in 70 of 76 patients (92%). Ten of 48 gastric cancer patients (21%) and three of 22 pancreatic cancer patients (14%) had positive percutaneous and laparoscopic PC. Two additional gastric cancer patients had positive laparoscopic PC only. Sensitivity and specificity of percutaneous compared to laparoscopic PL was 87% and 100%, respectively. No complications occurred with percutaneous PL.

Conclusions—Percutaneous PL is a safe and effective minimally-invasive alternative to laparoscopic PL for the diagnosis of metastatic gastric and pancreatic cancer. It is possible this can be utilized in an outpatient setting, such as during endoscopy, to allow for earlier diagnosis of M1 disease and decreased time to appropriate treatment.

INTRODUCTION

Peritoneal lavage can be used to stage patients with gastric and pancreatic cancers. A common pathway for gastric cancer includes initial diagnosis with endoscopy, followed by staging with computed tomography (CT) and/or positron emission tomography (PET) scan, and endoscopic ultrasound if clinically indicated, then diagnostic laparoscopy with peritoneal lavage. Peritoneal cytology is routinely included in the staging algorithm for gastric cancer since positive cytology, even in the absence of visible peritoneal metastases,

represents stage IV disease^{1, 2}. Similarly, in pancreatic cancer, positive peritoneal cytology is prognostically equivalent to metastatic disease; however, the incidence of positive cytology in the absence of gross metastatic disease is lower than in gastric cancer and the practical utility of this procedure has been questioned^{3–7}. For some patients, positive peritoneal cytology may be the only evidence of metastatic disease found during laparoscopy^{8, 9}. Peritoneal lavage can be particularly useful in this patient population with no clinical evidence of metastatic disease in order to reduce the occurrence of unnecessary laparotomy and non-curative operative resections in those with radiographically-occult M1 disease.

While peritoneal lavage has only been performed laparoscopically in the oncologic setting, diagnostic peritoneal lavage (DPL) has been done percutaneously in the trauma setting since its introduction in 1965 for the rapid diagnosis of intraabdominal injury¹⁰. DPL is performed with local anesthetic through an infraumbilical incision. A soft catheter is inserted into the abdominal cavity using a Seldinger technique, and one-liter of warmed isotonic solution is infused and allowed to drain passively. Percutaneous DPL using a Veress needle has also been described with similar efficacy^{11–13}. A minimum of 10mL of fluid is sent for cell count analysis and a red blood cell count of >100,000/mL is considered positive. Large-scale studies of DPL in trauma have shown high sensitivity and specificity for detecting intraabdominal injury of 87%–96% and 97%–99%, respectively^{14, 15}. The overall complication rate with either open or percutaneous DPL is extremely low, occurring in <1% of cases^{16, 17}.

In this study, we propose the adaptation of a procedure that has been effectively used in trauma to the rapid staging of gastric and pancreatic cancer. The goal of this study is to compare minimally-invasive percutaneous peritoneal lavage with the current standard of laparoscopic lavage.

METHODS

This was a single-institution, single-arm, prospective trial. 115 patients with gastric or pancreatic cancer scheduled for diagnostic laparoscopy at Memorial Sloan-Kettering Cancer Center were prospectively reviewed for study enrollment from November 2010 to September 2012. All patients were potential candidates for resection. Patients were excluded if there was any evidence of metastatic disease on cross-sectional imaging within six weeks of the procedure date or any other synchronous abdominal malignancies. This study was approved by the institutional review board. Informed consent was obtained from all patients.

The primary objective was to determine the concordance of percutaneous and laparoscopic lavage in diagnosing intraperitoneal metastases. The lavage cytology outcome examined for each patient was binary: positive or negative. Atypical cytology was characterized as negative and suspicious cytology was characterized as positive, consistent with current practice. In order to test the null hypothesis that sensitivity was at least 80%, we planned to accrue patients until we identified at least ten gastric cancer patients and ten pancreatic cancer patients with positive lavage. This sample size was obtained in gastric cancer patients but was unable to be achieved in pancreatic cancer patients given the significantly lower incidence of positive lavage cytology in this patient population.

Both percutaneous and laparoscopic peritoneal lavage was performed in the operating room under general anesthesia by one of seven attending surgical oncologists. Percutaneous lavage was performed first. A Veress needle was inserted in the standard fashion in the left upper quadrant of the patient's abdomen and intraperitoneal placement of the needle was confirmed by gravity infusion of 5mL of normal saline. A guidewire was placed through the Veress needle and a 9-French peritoneal catheter was inserted over the guidewire utilizing the Seldinger technique. A goal of 800mL of warmed normal saline was infused into the abdomen and a minimum of 5mL of peritoneal fluid was drawn back through the catheter; if available, additional peritoneal fluid was withdrawn through the catheter and added to the initial sample. In cases where only a limited volume of solution could be infused, this was accepted if there was adequate fluid return to send for cytology. In other cases, additional fluid was infused to enable sufficient specimen collection. After this percutaneous specimen was obtained, the wire and catheter were left in place, and laparoscopy was performed through the same left upper quadrant incision. Laparoscopic washings were performed in the right and upper quadrants, and pelvis. A minimum of 5mL of peritoneal fluid was obtained laparoscopically from each quadrant using a suction device and also sent for cytology. Additional warmed normal saline was infused as needed to obtain sufficient laparoscopic samples. All specimens underwent cytologic evaluation by an institutional pathologist. Positive cytology was defined by the presence of any malignant cells, regardless of the number of malignant cells. In the event of discordant results between samples from the same patient, such as a finding of positive percutaneous lavage but negative laparoscopic lavage, the patient was considered to have a positive lavage.

The primary outcome was to determine the sensitivity and specificity of minimally-invasive percutaneous peritoneal lavage for rapid staging of gastric and pancreatic cancer, in comparison with the current standard of care of laparoscopic lavage. The secondary outcome was to evaluate the safety of this percutaneous technique. Safety was measured in the number of bowel, major omental, or major vascular injuries.

Data analysis was performed using IBM SPSS version 22 and R 3.1.1 (R Foundation, Vienna, Austria). The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of percutaneous peritoneal lavage in determining positive peritoneal cytology compared with laparoscopic peritoneal lavage were calculated. Exact confidence intervals were calculated and when estimates were equal to 100%, the lower limit was estimated as $100 \times (1 - (3/n))$ according to the "rule of three"¹⁸. Only patients with cytology results from both percutaneous and laparoscopic lavage were included in this analysis. An intention-to-treat analysis was not performed as it is not possible or clinically relevant given the comparison of percutaneous lavage to the gold standard laparoscopic lavage. Instead, patients with only percutaneous or laparoscopic lavage cytology results were described separately. Overall survival (OS) was measured from time of procedure until time of last known follow-up or death. OS was estimated using Kaplan-Meier methods and compared using the log-rank test. A p -value $< .05$ was considered significant.

RESULTS

Seventy of the 76 patients (92.1%) who underwent attempted percutaneous peritoneal lavage had adequate percutaneous and laparoscopic specimen collection. Two patients had failed entry, defined as inability to access the abdomen using the Veress, or inability to pass the guidewire through the Veress; four additional patients had successful entry with inadequate fluid return for cytology. The 70 patients with adequate percutaneous and laparoscopic specimen collection were the focus of our analysis.

Forty-eight patients had gastric cancer (68.5%), and 22 patients had pancreatic cancer (31.4%). The median patient age was 65 years (range 44–87 years), with a predominance of male patients (43/70, 61.4%). Twenty-two of 48 gastric cancer patients (46%) had disease confined to the cardia and/or fundus, 22 (46%) to the body and/antrum, and 4 (8%) with diffuse gastric disease. Fifteen of 22 pancreatic cancer patients (68.2%) had disease confined to the proximal pancreas, and 7 (31.8%) in the distal pancreas. Patient demographics and presenting characteristics are summarized in Table 1.

Intraoperatively, the median amount of percutaneous fluid return was 60mL (range 10–400mL). No complications occurred during percutaneous peritoneal lavage. A laparoscope was inserted immediately after performance of percutaneous peritoneal lavage to confirm the absence of any bowel, omental, or vascular injury (Table 2).

Ten of 48 gastric cancer patients (20.8%) had positive percutaneous lavage cytology (Table 2). All ten patients were also positive on laparoscopic lavage; an additional two patients, who had negative percutaneous lavage, had positive laparoscopic lavage. Four of these twelve gastric cancer patients with positive peritoneal cytology also had visible metastatic disease during laparoscopy (three peritoneal, one omental). Ten patients with positive cytology had T4 primary gastric tumors and two patients had T3 primary tumors. Three of 22 pancreatic cancer patients (13.6%) had positive peritoneal cytology on both percutaneous and laparoscopic lavage; all three patients also had visible metastatic disease during laparoscopy (2 peritoneal, 1 hepatic). For gastric cancer patients, there was 95.8% concordance in peritoneal cytology between percutaneous and laparoscopic peritoneal lavage, and 100% for pancreatic cancer patients. The overall sensitivity and specificity of percutaneous peritoneal lavage compared with laparoscopic peritoneal lavage was 86.7% (95%CI: 59.5%–98.3%) and 100% (95%CI: 94.5% –100%), respectively, which corresponded with PPV of 100% (95%CI: 76.9% –100%) and NPV of 96.5% (95%CI: 87.9% –99.6%) (Table 3).

Four patients (6%) were found to have gross metastatic disease during diagnostic laparoscopy despite having both negative percutaneous and laparoscopic peritoneal cytology. This occurred in one gastric cancer and one pancreatic cancer patient with peritoneal disease, and two pancreatic cancer patients with liver lesions.

Within the 6 patients who had technical failure of percutaneous lavage due to either failed entry or inadequate specimen collection, there was one case of positive laparoscopic cytology in a gastric cancer patient, and another in a pancreatic cancer patient, both with visible peritoneal disease on diagnostic laparoscopy. One other pancreatic cancer patient had

negative laparoscopic cytology but visible hepatic metastatic disease on diagnostic laparoscopy.

Median follow-up for all surviving patients was 44 months. Median follow-up for gastric cancer patients was 46 months. For those with positive peritoneal cytology, two-year survival was 25.0% (95% CI 9.4% –66.6%), compared with 74.5% (95% CI 61.4% –90.4%) for those with negative peritoneal cytology ($p<.001$) (Figure 1a). Median follow-up for pancreatic cancer patients was 8 months, but 4 of the 9 surviving patients had follow-up of over 40 months. For those with positive peritoneal cytology, two-year survival was 0%, compared with 34.8% (95% CI 17.3% –70.0%) for those with negative peritoneal cytology ($p<.001$) (Figure 1b).

DISCUSSION

In this prospective study of 70 gastric or pancreatic cancer patients, percutaneous peritoneal lavage achieved high sensitivity and specificity for evaluating peritoneal cytology, compared to the current standard of laparoscopic peritoneal lavage. Patients who have reached this step in the diagnostic algorithm are usually candidates for resection with otherwise no evidence of metastatic disease. For both gastric and pancreatic cancer, positive peritoneal cytology is classified as M1 disease, and thus stage IV disease. If metastatic disease is identified through peritoneal cytology, treatment recommendations shift dramatically from resection to palliative therapy.

Peritoneal cytology remains a powerful staging and prognostic tool as it has been shown to be a significant predictor of patient outcomes in gastric and pancreatic cancer and a marker of poor OS regardless of resection status. Similar to previous studies in both gastric and pancreatic cancer, we identified a significant survival difference between patients with positive and negative peritoneal cytology. Burke et al reviewed the long-term survival of 127 gastric cancer patients who underwent laparoscopic peritoneal lavage¹⁹. OS was significantly reduced in patients with positive peritoneal cytology who underwent resection, and matched that of unresected patients with macroscopic M1 disease. Similarly, Bando et al found positive peritoneal cytology to be strongly correlated with peritoneal carcinomatosis and significantly decreased OS in 1,297 gastric cancer patients of whom 24% had positive peritoneal cytology; the 5-year OS for patients with negative peritoneal cytology was 58% but only 2% for those with positive cytology²⁰. Increased incidences of positive cytology were found with higher T stage primary tumors. Similarly, in our study, positive cytology was most commonly found in gastric cancer patients with T4 tumors.

The significance of positive peritoneal cytology in pancreatic cancer is similar to gastric cancer, with decreased survival, again, regardless of resection status^{3, 21}. Previous studies report median OS of 10–11 months in pancreatic cancer patients with positive peritoneal cytology, compared with 16–27 months in those with negative cytology^{9, 22}. This re-emphasizes that positive cytology identifies microscopic peritoneal disease and signifies tumor dissemination. In a larger study of 462 patients with radiographically-resectable pancreatic cancer, Ferrone et al found significantly decreased OS among patients who underwent resection in the setting of positive peritoneal cytology²³. This poor survival

reported among resected gastric or pancreatic cancer patients with positive cytology suggests that resection is of limited benefit for these patients, and systemic therapies need be considered instead.

In this study, we found the overall prevalence of positive peritoneal cytology to be lower in pancreatic cancer patients compared with gastric cancer patient (20.8% vs 13.6%). The three pancreatic patients in our study with positive peritoneal cytology all had visible peritoneal disease on diagnostic laparoscopy; there were no cases of patients with only microscopic metastatic disease. This raises the question of the incremental value of peritoneal cytology in pancreatic cancer patients as it may not identify any new M1 disease compared with laparoscopic visualization alone.

Our study is unique as one of the earliest prospective studies to demonstrate the use of percutaneous peritoneal lavage in an oncologic setting, and to examine this in both gastric and pancreatic cancer. The only oncologic precedent to the percutaneous technique is in a small series of 27 gastric cancer patients who also underwent percutaneous peritoneal lavage followed by laparoscopic lavage²⁴. In this study, comparable to ours, percutaneous lavage was successful in 22/27 patients (81.5%). The sensitivity and specificity of percutaneous lavage was also similar (92.3% and 100%, respectively). Our results emphasize the potential of percutaneous peritoneal lavage for early rapid detection of metastatic disease in both gastric and pancreatic cancer patients. The percutaneous technique introduces the possibility of performing this step of the diagnostic algorithm in a monitored setting outside the operating room. For gastric patients, this may occur at time of endoscopic ultrasound, and for pancreatic patients, at the time of endoscopic biopsy or stent placement. This can be particularly helpful in gastric cancer patients who require serial peritoneal lavages, such as before and after chemotherapy, as clearing of positive cytology by chemotherapy is a known positive prognostic indicator²⁵.

A significant limitation to percutaneous peritoneal lavage is the inability to visually inspect the intraabdominal compartment. Of the 70 evaluable patients in our study, one gastric cancer patient and three pancreatic cancer patients had visible metastatic disease on direct laparoscopy that was neither identified by percutaneous or laparoscopic peritoneal cytology. While the identification of positive peritoneal cytology confirms M1 disease, sparing patients unnecessary diagnostic laparoscopy and laparotomy, patients with negative peritoneal cytology should continue to diagnostic laparoscopy to capture these potentially missed M1 cases.

CONCLUSION

Percutaneous peritoneal lavage is an effective tool in the rapid diagnosis of metastatic gastric and pancreatic cancer, with comparable sensitivity and specificity to the current standard of laparoscopic peritoneal lavage. However, given the overall low incidence of positive peritoneal cytology in pancreatic cancer compared with gastric cancer, this technique may be of greatest practical utility in gastric cancer. Future applications for this percutaneous technique include use in monitored settings outside the operating room for early identification of metastatic disease and initiation of appropriate systemic treatment.

Acknowledgments

Conflicts of Interest/Disclosures: Dr. Linda Pak received support from the Clinical and Translation Science Center at Weill Cornell Medical Center and MSKCC (grant number UL1TR00457). This work was supported in part by NIH/NCI P30 CA008748 Cancer Center Support Grant.

References

1. Washington K. 7th edition of the AJCC cancer staging manual: stomach. *Ann Surg Oncol*. 2010; 17(12):3077–9. [PubMed: 20882416]
2. Edge, SBBDR., Compton, CF., Fritz, AG., Greene, FL., Trotti, A. *AJCC Cancer Staging Manual*. 7. New York: Springer; 2010.
3. Leach SD, Rose JA, Lowy AM, et al. Significance of peritoneal cytology in patients with potentially resectable adenocarcinoma of the pancreatic head. *Surgery*. 1995; 118(3):472–8. [PubMed: 7652681]
4. Lei S, Kini J, Kim K, et al. Pancreatic cancer. Cytologic study of peritoneal washings. *Arch Surg*. 1994; 129(6):639–42. [PubMed: 8204039]
5. Midwinter MJ, Watson A, Wadehra V, et al. Laparoscopic peritoneal lavage cytology and immunocytology in pancreatic and periampullary carcinoma. *HPB (Oxford)*. 2001; 3(3):207–11. [PubMed: 18333016]
6. Jimenez RE, Warshaw AL, Rattner DW, et al. Impact of laparoscopic staging in the treatment of pancreatic cancer. *Arch Surg*. 2000; 135(4):409–14. discussion 414–5. [PubMed: 10768705]
7. Nieveen van Dijkum EJ, Sturm PD, de Wit LT, et al. Cytology of peritoneal lavage performed during staging laparoscopy for gastrointestinal malignancies: is it useful? *Ann Surg*. 1998; 228(6):728–33. [PubMed: 9860470]
8. Jimenez RE, Warshaw AL, Fernandez-Del Castillo C. Laparoscopy and peritoneal cytology in the staging of pancreatic cancer. *J Hepatobiliary Pancreat Surg*. 2000; 7(1):15–20. [PubMed: 10982586]
9. Clark CJ, Traverso LW. Positive peritoneal lavage cytology is a predictor of worse survival in locally advanced pancreatic cancer. *Am J Surg*. 2010; 199(5):657–62. [PubMed: 20466112]
10. Root HD, Hauser CW, McKinley CR, et al. Diagnostic peritoneal lavage. *Surgery*. 1965; 57:633–7. [PubMed: 14295771]
11. Cue JI, Miller FB, Cryer HM 3rd, et al. A prospective, randomized comparison between open and closed peritoneal lavage techniques. *J Trauma*. 1990; 30(7):880–3. [PubMed: 2381005]
12. Saunders CJ, Battistella FD, Whetzel TP, et al. Percutaneous diagnostic peritoneal lavage using a Veress needle versus an open technique: a prospective randomized trial. *J Trauma*. 1998; 44(5): 883–8. [PubMed: 9603093]
13. Hodgson NF, Stewart TC, Girotti MJ. Open or closed diagnostic peritoneal lavage for abdominal trauma? A meta-analysis. *J Trauma*. 2000; 48(6):1091–5. [PubMed: 10866256]
14. Fischer RP, Beverlin BC, Engrav LH, et al. Diagnostic peritoneal lavage: fourteen years and 2,586 patients later. *Am J Surg*. 1978; 136(6):701–4. [PubMed: 717650]
15. Henneman PL, Marx JA, Moore EE, et al. Diagnostic peritoneal lavage: accuracy in predicting necessary laparotomy following blunt and penetrating trauma. *J Trauma*. 1990; 30(11):1345–55. [PubMed: 2231803]
16. Davis JW, Hoyt DB, Mackersie RC, et al. Complications in evaluating abdominal trauma: diagnostic peritoneal lavage versus computerized axial tomography. *J Trauma*. 1990; 30(12):1506–9. [PubMed: 2258962]
17. Nagy KK, Roberts RR, Joseph KT, et al. Experience with over 2500 diagnostic peritoneal lavages. *Injury*. 2000; 31(7):479–82. [PubMed: 10908739]
18. Hanley JA, Lippman-Hand A. If nothing goes wrong, is everything all right? Interpreting zero numerators. *Jama*. 1983; 249(13):1743–5. [PubMed: 6827763]
19. Burke EC, Karpeh MS Jr, Conlon KC, et al. Peritoneal lavage cytology in gastric cancer: an independent predictor of outcome. *Ann Surg Oncol*. 1998; 5(5):411–5. [PubMed: 9718170]
20. Bando E, Yonemura Y, Takeshita Y, et al. Intraoperative lavage for cytological examination in 1,297 patients with gastric carcinoma. *Am J Surg*. 1999; 178(3):256–62. [PubMed: 10527450]

21. Makary MA, Warshaw AL, Centeno BA, et al. Implications of peritoneal cytology for pancreatic cancer management. *Arch Surg.* 1998; 133(4):361–5. [PubMed: 9565114]
22. Hirabayashi K, Imoto A, Yamada M, et al. Positive Intraoperative Peritoneal Lavage Cytology is a Negative Prognostic Factor in Pancreatic Ductal Adenocarcinoma: A Retrospective Single-Center Study. *Front Oncol.* 2015; 5:182. [PubMed: 26301205]
23. Ferrone CR, Haas B, Tang L, et al. The influence of positive peritoneal cytology on survival in patients with pancreatic adenocarcinoma. *J Gastrointest Surg.* 2006; 10(10):1347–53. [PubMed: 17175453]
24. Mezhir JJ, Posner MC, Roggin KK. Prospective clinical trial of diagnostic peritoneal lavage to detect positive peritoneal cytology in patients with gastric cancer. *J Surg Oncol.* 2013; 107(8):794–8. [PubMed: 23532564]
25. Mezhir JJ, Shah MA, Jacks LM, et al. Positive peritoneal cytology in patients with gastric cancer: natural history and outcome of 291 patients. *Ann Surg Oncol.* 2010; 17(12):3173–80. [PubMed: 20585870]

SYNOPSIS

Positive peritoneal cytology is classified as M1 disease in gastric and pancreatic cancer. While peritoneal cytology is typically obtained by laparoscopic peritoneal lavage, this study demonstrated that percutaneous peritoneal lavage is a safe and effective minimally-invasive alternative technique.

Figure 1.

a. Overall survival of gastric cancer patients stratified by lavage cytology.

b. Overall survival of pancreatic cancer patients stratified by percutaneous lavage cytology.

Table 1

Patient demographics and presenting characteristics.

	Gastric Cancer n = 48 (68.5%)	Pancreatic Cancer n = 22 (31.4%)
Age of procedure, median (range)	63 (44–81)	69 (50–87)
Gender, male	29 (60%)	14 (64%)
Preoperative weight loss Number of pounds, median	21 (44%) 15	6 (27%) 14
Preoperative jaundice	0	9 (41%)
Preoperative CA 19-9, median (IQR)	22 (10–55)*	166 (45–611) [‡]
Cancer location cardia/fundus body/antrum diffuse	 22 (46%) 22 (46%) 4 (8%)	
Cancer location uncinate/head/neck body/tail		 15 (68%) 7 (32%)

* Preoperative CA 19-9 values were only available in 21 of 48 gastric cancer patients.

[‡]Preoperative CA 19-9 values were only available in 21 of 22 pancreatic cancer patients.

CA 19-9 indicates carbohydrate antigen 19-9; IQR, interquartile range

Table 2

Peritoneal lavage details and intraoperative findings.

	Gastric Cancer n = 48	Pancreatic Cancer n = 22	All n = 70
Amount of percutaneous fluid injected, mL, median (range)	800 (350–1200)	800 (500–1000)	800 (350–1200)
Amount of percutaneous fluid returned, mL, median (range)	60 (5–100)	60 (10–400)	60 (5–400)
Percent of percutaneous fluid returned, median (range)	6.1% (.8%–16%)	7.5% (1.3%–50%)	6.7% (.8%–50%)
Percutaneous lavage complications	0	0	0
Visible metastatic disease	5 (10.4%)	6 (27%)	11 (15.7%)
liver	0	3	3
peritoneum	4	3	7
omentum	1	0	1
Positive percutaneous lavage	10 (20.8%)	3 (13.6%)	13 (18.5%)
Positive laparoscopic lavage	12 (25.0%)	3 (13.6%)	15 (21.4%)
Concordance between percutaneous and laparoscopic lavage	95.8%	100%	97.1%
Missed by percutaneous lavage	2/12 (16.7%)	0	2/15 (13.3%)

mL indicates milliliters

Table 3

Comparison of percutaneous peritoneal lavage cytology with laparoscopic peritoneal lavage cytology.

	Positive Laparoscopic Lavage	Negative Laparoscopic Lavage
Positive Percutaneous Lavage	13	0
Negative Percutaneous Lavage	2	55
Sensitivity [95% CI]	13/15 (86.7%) [59.5%–98.3%]	
Specificity [95% CI]	55/55 (100%) [94.5%–100%]	
Positive predictive value (PPV) [95% CI]	13/13 (100%) [76.9%–100%]	
Negative predictive value (NPV) [95% CI]	55/57 (96.5%) [87.9%–99.6%]	

CI indicates confidence interval