

CT colonography to detect rectosigmoid involvement in patients with primary ovarian cancer

K. Kato¹, H. Funatsu², K. Suzuka¹, T. Osaki¹, A. Imamura², H. Takano², N. Tanaka¹

¹Department of Gynecology, ²Department of Diagnostic Radiology, Chiba Cancer Center, Chiba (Japan)

Summary

Introduction: We retrospectively evaluated the performance of preoperative computed tomographic (CT) colonography to detect tumor involvement of the rectosigmoid wall and predict the need for rectosigmoid resection in patients with primary ovarian cancer. **Methods:** Thirty-three patients with primary ovarian cancer who underwent preoperative CT colonographic examination were evaluated. The images of the examination were analyzed and compared with the subsequent surgical findings. **Results:** All abnormal findings (malignant infiltration of the rectosigmoid mucosa and extrinsic compression) revealed by conventional colonoscopy were correctly observed as extrinsic compression using CT colonography. The sensitivity, specificity, positive predictive value and negative predictive value of CT colonography for the prediction of rectosigmoid resection were 100%, 64.7%, 72.7%, and 100%, respectively. Though conventional colonoscopic examinations could not be completed in five patients because of the presence of extrinsic stenosis and occlusion at the sigmoid colon, CT colonography enabled the entire large bowel to be examined in these patients. **Conclusions:** This preliminary study showed that the CT colonographic examination is feasible and safe. CT colonography seems to have several advantages over conventional colonoscopy for the detection of rectosigmoid involvement in patients with advanced ovarian cancer. For confirmation of the efficacy of CT colonography, further large prospective studies are needed.

Key words: Ovarian cancer; Computed tomographic colonography; Rectosigmoid resection.

Introduction

Advanced ovarian cancer spreads intraperitoneally in areas where ascites stagnate, like in the paracolic gutters, the dome of the diaphragm, along the greater omentum, and in the pelvis [1]. Therefore, ovarian and disseminated tumors frequently present with gastrointestinal involvement. The effectiveness of optimal cytoreductive surgery for the management of advanced ovarian cancer has been accepted, and an apparent survival benefit for patients whose largest residual tumor is no greater than 1 cm has been demonstrated [2]. Bowel resection is frequently required to achieve optimal cytoreduction [3, 4].

Some investigators have studied the roles of preoperative sigmoidoscopy or colonoscopy in patients with ovarian cancer [5-7]. However, endoscopic techniques are associated with some major problems, including considerable patient discomfort and pain. In addition, failure to visualize the entire colorectal surface possibly occurs in not just a few patients with advanced ovarian cancer because of the presence of extrinsic stenosis and occlusion of the large bowel arising from ovarian and disseminated tumors.

Computed tomographic (CT) colonography is a new tool that combines abdominal helical CT scanning and virtual reality computer technology; the reconstructed images provide a simulation of the luminal surface of the large bowel as viewed during a colonoscopy [8]. Visualization of the entire large bowel, even in the presence of stenosing lesions, and the ability to assess extracolonic abdominal and pelvic organs are the most relevant advantages of this procedure [9-11].

In this retrospective study, we evaluated the performance of preoperative CT colonography for detecting rectosigmoid involvement and predicting the need for rectosigmoid resection in patients with primary ovarian cancer.

Materials and Methods

From May 2005 to June 2007, 35 patients with a high suspicion of primary ovarian cancer had preoperative CT colonographic examinations. CT colonography was indicated in patients with a fixed pelvic mass and at least two additional features from suspected ovarian tumor on ultrasound and magnetic resonance imaging, elevated CA125 value (> 500 U/ml) or presence of ascites. This was a modification of criteria for inclusion previously described by Gornall et al. [5]. The exclusion criteria included the presence of metastatic ovarian cancers that had already been diagnosed before admission to our department, impending colorectal obstruction, and the performance of a barium examination in the preceding 14 days. All patients underwent debulking surgeries at the gynecologic department of our institution. As the final histopathological examination confirmed primary colon cancer metastatic to the ovary in one patient, and borderline tumor of the ovary in another patient; these two patients were excluded from the analysis. Thus, a total of 33 patients were evaluated in this study.

Almost all patients underwent the CT colonography following the conventional colonoscopy two days before surgery. Before the colonoscopic examination, each patient was given a standard preparation consisting of polyethylene glycol 4000 electrolyte solution, diluted in two liters of water. The colonoscopies were performed by endoscopists on staff at our institution. A standard videoendoscope (CF-H260AI, Olympus, Tokyo, Japan) was used in all cases. Informed consent was obtained from each patient.

Revised manuscript accepted for publication December 13, 2007

As soon as the conventional colonoscopy was finished, the patient was transferred to the CT suite. After the intravenous administration of butylscopolamine (20 mg), a rectal catheter was inserted for colonic insufflation with room air. CT colonography was performed using a 16-detector row CT scanner (Somatom Sensation 16; Siemens, Erlangen, Germany) and the following parameters: 0.75-mm slice collimation, 120 kVp, 160 mAs for the supine position and 35 mAs for the prone position, and a table feed/rotation of 15 mm. In each patient, the entire large bowel (as displayed on a topogram) was scanned in the cephalocaudal direction. Contrast material was intravenously administered, unless contraindicated. Scanning was started 40 seconds after the start of an injection of iodinated contrast material (Iohexol, Omnipaque 300; Daiichiseiyaku, Tokyo, Japan) using a power injector (Dual shot type-D; Nemoto Kyorindo, Tokyo, Japan) through a 20-gauge cannula at a rate of 4.0 ml/sec. Images were obtained with the patient in supine and prone positions. The acquired images were processed using a commercially available workstation (Virtual Place Advance 300, version 3.0041; Aze, Tokyo, Japan). The staff radiologists created three-dimensional (3D) reconstructions and performed the interpretations of the 3D images.

Findings of CT colonography were reported as "normal findings or only minor abnormal findings", "extrinsic compression associated with smooth surface" or "extrinsic compression associated with irregular surface". We considered the rectosigmoid wall to be involved when abnormal findings ("extrinsic compression associated with smooth surface" and "extrinsic compression associated with irregular surface") were observed.

All the surgeries were performed at the gynecologic department of our institution. Twenty-one patients underwent primary debulking surgery. Twelve patients with Stage IV disease (with pleural effusion, lung metastasis and liver metastasis) or with a poor performance status were treated using neoadjuvant chemotherapy, followed by interval debulking surgery. Surgical specimens were fixed in 10% buffered formaldehyde solution and routinely processed. In cases that rectosigmoid resections were performed as part of the cytoreductive surgery, the extent of tumor invasion in the rectosigmoid wall was histopathologically evaluated.

Results

The clinicopathological features of the patients evaluated in this retrospective study are summarized in Table 1.

No clinically significant complications were encountered during the conventional colonoscopies and the CT colonographies. The average time spent by the patients in the CT suite was 15 minutes. Three-dimensional reconstructions were successfully performed in all the patients. All abnormal findings in the rectosigmoid arising from ovarian tumor and disseminated tumor spread, which were revealed by conventional colonoscopy (malignant infiltration of the rectosigmoid mucosa and extrinsic compression), were correctly detected as extrinsic compression using CT colonography. A typical example of a CT colonography image in a patient with advanced ovarian cancer is demonstrated in Figure 1.

Comparison of CT colonographic findings in the patients performed with or without rectosigmoid resection is shown in Table 2. CT colonography visualized extrinsic compression associated with an irregular surface in two patients. This CT colonographic visualiza-

Table 1. — Patient characteristics (N = 33).

Characteristic	Result
Mean (range) age (years)	53.5 (26-75)
Preoperative serum CA125	
200-500 U/ml	3
501-1000 U/ml	7
> 1000 U/ml	23
Largest tumor size	
< 50 mm	2
50-100 mm	6
> 100 mm	25
Histology	
Serous	21
Clear cell	5
Endometrioid	4
Mucinous	3
FIGO stage	
II	1
III	24
IV	8
Depth of tumor infiltration in the rectosigmoid wall (N = 16)	
Mucosa	2
Submucosa	1
Proper muscularis	5
Serosa/subserosa	4
No infiltration	4

N: number of patients.

Table 2. — CT colonography findings in the rectosigmoid of the patients with primary ovarian cancer according to type of operation.

	Rectosigmoid resection performed (N = 16)	No rectosigmoid resection (N = 17)
Extrinsic compression		
+ irregular surface	2	0
Extrinsic compression		
+ smooth surface	14	6
Normal findings or minor abnormal findings only	0	11

N: number of patients.

tion corresponded to a tumor infiltration of the rectosigmoid mucosa, as confirmed histopathologically in the surgical specimens (Figure 2). Though conventional colonoscopy was not completed in five cases (15.2%) because of the presence of stenosis and occlusion at the sigmoid colon, CT colonography was successfully used to examine the entire large bowel in these cases. Consequently, CT colonography revealed that the stenosis and occlusion at the sigmoid colon was caused by ovarian and disseminated tumor involvement of the rectosigmoid wall in all five patients.

Among the 33 patients in this study, 26 patients had residual tumor with a maximal diameter of < 1 cm, of which 20 patients had no visible tumor. Rectosigmoid resections were performed in 17 patients. CT colonography showed abnormal findings in all the 12 patients who underwent rectosigmoid resection.

Evaluated on the basis of preoperative CT colonographic examinations, rectosigmoid resections were per-

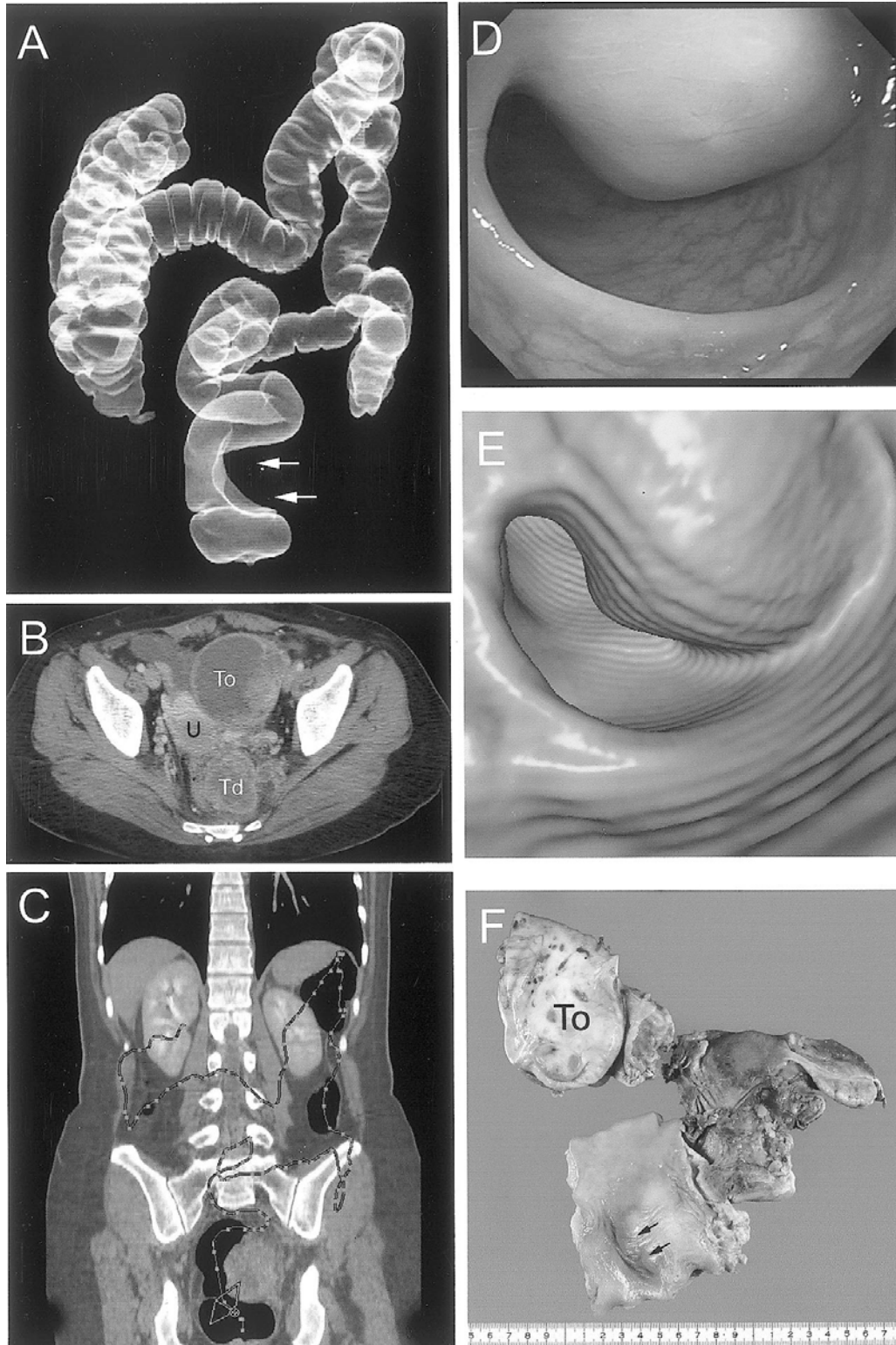


Figure 1. — Left ovarian cancer and disseminated tumor involvement of the cul-de-sac in a 44-year-old female. (A) Schematic representation of the air-filled colon generated from a computed tomographic (CT) scan, showing extrinsic compression in the lower rectum (arrows). (B) Axial two-dimensional CT image showing a left ovarian tumor (To) and a disseminated tumor in the cul-de-sac (Td). U, uterus. (C) Coronal two-dimensional CT image showing an endoluminal projection in the rectum arising from disseminated tumor involvement of the cul-de-sac. The dotted line represents the centerline and is automatically generated to assist virtual navigation. (D) Conventional colonoscopy image showing extrinsic compression in the rectum. (E) Three-dimensional virtual colonoscopy image showing extrinsic compression with a smooth mucosal surface in the rectum. (F) Macroscopic dorsal view of an en bloc low anterior resection of the uterus, adnexa, pelvic tumor, and rectosigmoid. Rectal extrinsic compression arising from the disseminated tumor in the cul-de-sac can be seen (arrows). Histopathological sections of the specimen showed tumor infiltration into the proper muscularis of the rectal wall. The primary left ovarian tumor (To) was histopathologically confirmed to be a mucinous adenocarcinoma.

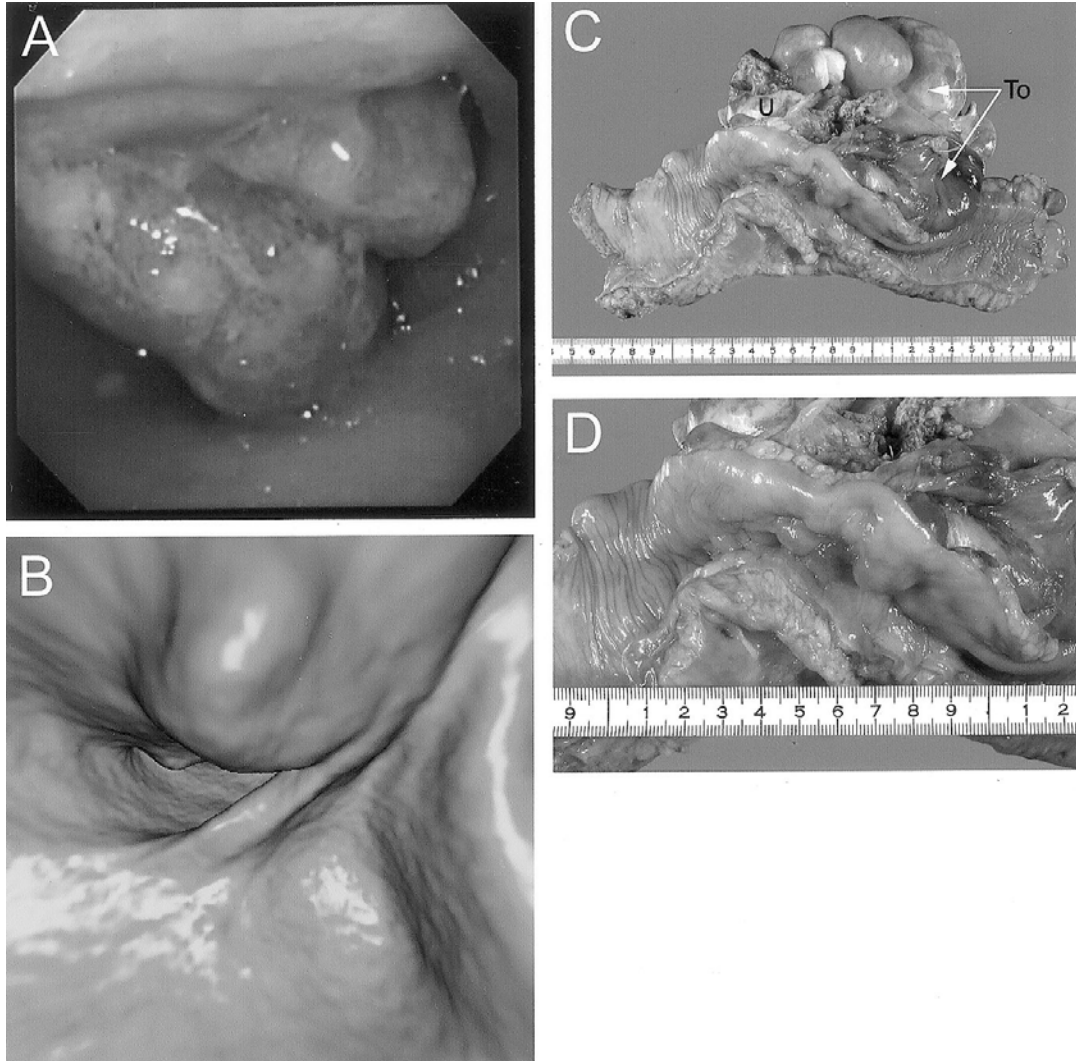


Figure 2. — Bilateral ovarian cancer and disseminated tumor involvement of the sigmoid colon in a 40-year-old female. (A) Conventional colonoscopy image showing tumor infiltration into the mucosa of the sigmoid colon. (B) Three-dimensional virtual colonoscopy image showing extrinsic compression with an irregular surface in the sigmoid colon. (C) Macroscopic view of an en bloc low anterior resection of the pelvic tumors, uterus (U), and rectosigmoid. The primary tumor in the right ovary, which was histopathologically confirmed to be a serous adenocarcinoma, was separately resected during the operation. Multiple myoma nodules in the uterine corpus can be seen. To, left ovarian tumor. (D) Close-up view of the specimen showing the site of tumor involvement in the sigmoid colon. Histopathological sections of the specimen showed disseminated tumor infiltration into the mucosa of the colonic wall.

formed in 16 out of 22 patients with abnormal findings. The sensitivity and specificity of CT colonography for the prediction of rectosigmoid resection were 100% and 64.7%, respectively. The positive predictive value (PPV) and negative predictive value (NPV) were 72.7% and 100%, respectively.

Discussion

The effectiveness of optimal cytoreductive surgery for the management of advanced epithelial ovarian cancer has been commonly accepted, and multiple studies have reported that bowel resection is frequently required to achieve optimal cytoreduction [3, 4]. Some investigators

have reported that the rates of bowel resection during the treatment of advanced ovarian cancer have increased to over 40% [2, 4]. Colorectal resection is the most commonly performed procedure for ensuring the complete removal of all visible tumors, a factor associated with the improved survival of patients with advanced ovarian cancer. Eisenkop et al. described the use of a modified pelvic exenteration with a low rectal anastomosis in 85 (52.1%) of 163 patients with Stage III or IV ovarian cancer [2]. The complete removal of all visible tumors was possible in 139 (85.3%) of the 163 patients. Hertel et al. evaluated 100 patients with Stage III ovarian cancer who underwent rectosigmoid resection for the removal of macroscopic suspected tumor involvement of the cul-de-

sac [1]. Tumor involvement of the colorectal wall was confirmed histopathologically in 73% of the patients. They concluded that pelvic en bloc surgery with rectosigmoid resection was necessary if complete debulking was the aim of the operations for advanced ovarian cancer. In the present study, tumor involvement of the colorectal wall was histopathologically confirmed in 12 (75%) of 16 patients who underwent rectosigmoid resection. Since the present study included only patients with a high suspicion of advanced ovarian cancer, the performance rate of rectosigmoid resection was relatively high compared with previous studies using endoscopic examinations [5-7].

With the development of new methods for image processing of the volumetric datasets obtained during spiral CT, interest in the potential of CT for the detection of colorectal cancer has become widespread [8]. Currently, CT colonography is seen as a promising imaging modality for the evaluation of the large bowel, in which spiral CT data sets can be used to generate two-dimensional images as well as virtual 3D, endoscopic-like views of the large bowel [8-11]. This preliminary study showed that CT colonography following conventional colonography is feasible and safe, and 3D reconstructions were successfully performed in all 33 patients. CT colonography showed extrinsic compression associated with an irregular surface in two patients. A correspondence between this CT colonographic finding and tumor involvement of the rectosigmoid mucosa was histopathologically confirmed in the surgical specimens.

Both prospective and retrospective studies have investigated the use of preoperative bowel examinations, including colonoscopy and barium enema, in patients with suspected ovarian cancer [5-7, 12]. Most of these studies concluded that assessing which patients have tumor involvement of the colorectal wall and predicting which patients will require colorectal surgery are difficult, but in reality preoperative bowel examinations have been performed in patients with ovarian cancer at a number of institutions. We also performed routine preoperative colonoscopy in all the patients with supposed advanced ovarian malignancy. Petru et al. reported that endoscopy was capable of showing malignant involvement of the colorectal mucosa in only 4.3% of the patients with ovarian malignancies in a series of 254 patients with a suspected adnexal mass; thus, they reported that the sensitivity of preoperative endoscopy for predicting bowel surgery was low (6% for colonoscopy and 38% for sigmoidoscopy) [6]. As they considered only the cases with malignant involvement of the colorectal mucosa to have tumor involvement of the colorectal wall, the sensitivity was too low to predict the need for colorectal surgery. However, 28 (35.9%) of the 78 patients in whom a preoperative endoscopy showed abnormal findings (17 with malignant involvement of the colorectal mucosa and 61 with colorectal extrinsic compression) underwent bowel surgery. On the other hand, 27 (15.3%) of the 176 patients in whom a preoperative endoscopy revealed normal findings or only minor abnormalities, underwent bowel surgery. In another study of 30 patients

with suspected ovarian malignancies, preoperative sigmoidoscopy had a PPV of 100% and a NPV of 84% [5]. In this study, we considered the rectosigmoid wall to be involved when abnormal findings (“extrinsic compression associated with smooth surface” and “extrinsic compression associated with irregular surface”) were observed. Consequently, the sensitivity, specificity, PPV and NPV of CT colonography for predicting rectosigmoid resection were 100%, 64.7%, 72.7%, and 100%, respectively.

CT colonography has several advantages over conventional colonoscopy. Firstly, CT colonography promises to have high patient acceptability (because of its non-invasiveness, quick examination time, and lack of intravenous sedation). Secondly, CT colonography enables the entire large bowel to be examined, even when a conventional colonoscopy cannot be completed. A complete colonoscopy provides the most thorough evaluation of the large bowel, with the added benefit of allowing biopsies of regions suspected of tumor involvement [9]. However, visualization of the entire large bowel using conventional colonoscopy can be interrupted by several factors, including the existence of occlusive lesions, the endoscopist's lack of skill, and the patient's intolerance of the procedure. Conventional colonoscopy reportedly fails to visualize the cecum in 4.3% of patients with primary ovarian cancer [7]. As the present series included only the patients with advanced ovarian cancer, the rate of incompleteness of conventional colonoscopy was relatively high (15.2%). However, CT colonography successfully examined the entire large bowel in these patients, and revealed that the stenosis and occlusion at the sigmoid colon was due to ovarian and disseminated tumor involvement of the colonic wall. It is reported that CT colonography is more effective than a barium enema for completing colon examinations in patients with incomplete colonoscopies because excessive air in the bowel can make the performance of a barium enema difficult and untenable [9]. In this study, almost all patients underwent colonoscopic and CT colonographic examinations two days before surgery so that they would not need to receive bowel preparations on two separate occasions. We prefer using CT colonography to a barium enema when colonoscopy fails. Another benefit of CT colonography is the ability to provide extracolonic abdominal and pelvic findings [10]. Serracino-Inglott et al. reported that CT colonography detected extracolonic malignancies in 8% of 103 patients presenting with symptoms suggestive of colorectal pathology, including one patient with a primary ovarian tumor with uterine and colonic invasion [11]. We consider that this ability could be used to advantage in the preoperative evaluation of cases in which ovarian and disseminated tumors are suspicious for rectosigmoid involvement. The CT colonography images visualizing the tumors, large bowel, and afferent and efferent vessels could help in the planning for an en bloc resection.

All 3D images of CT colonography could be reviewed on a workstation at any time, assisting in the interpreta-

tion of the images and the planning of an appropriate surgical approach. The performance of preoperative modalities to detect rectosigmoid involvement may assist in surgical planning for the management of advanced ovarian cancer, enabling surgeries to be refined and performed more safely and improving the percentage of optimal cytoreductions that can be performed. Since CT colonographic technology is evolving, further improvements in the display of imaging data and methods that enable more efficient interpretations can be expected [11]. This preliminary study showed that the CT colonographic examination is feasible and safe, and that CT colonography seems to have several advantages over conventional colonoscopy for the detection of rectosigmoid involvement in patients with advanced ovarian cancer. However, the number of cases in the present study was too small to draw any final conclusions regarding the real value of this modality. Further large prospective studies are needed.

References

- [1] Hertel H., Diebold H., Herrmann J., Kohler C., Kuhne-Heid R., Possover M. *et al.*: "Is the decision for colorectal resection justified by histopathologic findings: a prospective study of 100 patients with advanced ovarian cancer". *Gynecol. Oncol.*, 2001, 83, 481.
- [2] Eisenkop S.M., Friedman R.L., Wang H.J.: "Complete cytoreductive surgery is feasible and maximizes survival in patients with advanced epithelial ovarian cancer: a prospective study". *Gynecol. Oncol.*, 1998, 69, 103.
- [3] Hoffman M.S., Griffin D., Tebes S., Cardosi R.J., Martino M.A., Fiorica J.V. *et al.*: "Sites of bowel resected to achieve optimal ovarian cancer cytoreduction: implications regarding surgical management". *Am. J. Obstet. Gynecol.*, 2005, 193, 582.
- [4] Jaeger W., Ackermann S., Kessler H., Katalinic A., Lang N.: "The effect of bowel resection on survival in advanced epithelial ovarian cancer". *Gynecol. Oncol.*, 2001, 83, 286.
- [5] Gornall R.J., Talbot R.: "Can flexible sigmoidoscopy predict need for colorectal surgery in ovarian carcinoma?" *Eur. J. Gynaecol. Oncol.*, 1999, 20, 13.
- [6] Petru E., Kurschel S., Walsberger K., Haas J., Tamussino K., Winter R.: "Can bowel endoscopy predict colorectal surgery in patients with an adnexal mass?" *Int. J. Gynecol. Cancer.*, 2003, 13, 292.
- [7] Ravizza D., Fiori G., Trovato C., Maisonneuve P., Bocciolone L., Crosta C.: "Is colonoscopy a suitable investigation in the preoperative staging of ovarian cancer patients?" *Dig Liver Dis.*, 2005, 37, 57.
- [8] Kay C.L., Kulling D., Hawes R.H., Young J.W., Cotton P.B.: "Virtual endoscopy-comparison with colonoscopy in the detection of space-occupying lesions of the colon". *Endoscopy*, 2000, 32, 226.
- [9] Macari M., Berman P., Dicker M., Milano A., Megibow A.J.: "Usefulness of CT colonography in patients with incomplete colonoscopy". *A.J.R. Am. J. Roentgenol.*, 1999, 173, 561.
- [10] Hara A.K., Johnson C.D., MacCarty R.L., Welch T.J.: "Incidental extracolonic findings at CT colonography". *Radiology*, 2000, 215, 353.
- [11] Serracino-Inglott F., Atkinson H.D., Jha P., Parker I., Anderson D.N.: "Early experiences with computed axial tomography colonography". *Am. J. Surg.*, 2004, 187, 511.
- [12] Guidozi F., Sonnendecker E.W.: "Evaluation of preoperative investigations in patients admitted for ovarian primary cytoreductive surgery". *Gynecol. Oncol.*, 1991, 40, 244.

Address reprint requests to:
 K. KATO, M.D.
 Department of Gynecology,
 Chiba Cancer Center,
 666-2 Nitona, Chuo-ku,
 Chiba, 260-8717 (Japan)
 e-mail: kkato@chiba-cc.jp