Quality Control by Photo Documentation for Evaluation of Laparoscopic and Open Colectomy with D3 Resection for Stage II/III Colorectal Cancer: Japan Clinical Oncology Group Study JCOG 0404

Kentaro Nakajima1, Masafumi Inomata1,*, Tomonori Akagi1, Tsuyoshi Etoh1, Kenichi Sugihara2, Masahiko Watanabe3, Seiichiro Yamamoto4, Hiroshi Katayama5, Yoshihiro Moriya4 and Seigo Kitano6

1Department of Gastroenterological and Pediatric Surgery, Oita University Faculty of Medicine, Oita, 2Department of Surgical Oncology, Tokyo Medical and Dental University, Tokyo, 3Department of Surgery, Kitasato University Hospital, Kanagawa, 4Division of Colorectal Surgery, National Cancer Center Hospital, Tokyo, 5JCOG Data Center, Multi-institutional Clinical Trial Support Center, National Cancer Center, Tokyo and 6Oita University Faculty of Medicine, Oita, Japan

*For reprints and all correspondence: Masafumi Inomata, Department of Gastroenterological and Pediatric Surgery, Oita University Faculty of Medicine, Hasama-machi, Oita 879-5593, Japan. E-mail: inomata@oita-u.ac.jp

Received January 22, 2014; accepted June 3, 2014

Objective: The quality of surgery with D3 resection in randomized controlled clinical trial [Japan Clinical Oncology Group study (JCOG0404)] was assessed by evaluation of the photo documentation of both open and laparoscopic surgeries.

Methods: A multi-institutional randomized-controlled trial (JCOG0404) was conducted to evaluate open and laparoscopic D3 resection (complete mesocolic excision + ligation and dissection at the root of the main vessels) for Stage II/III colon cancer (UMIN-CTR number C000000105). A total of 1057 (open, 528; laparoscopic, 529) eligible patients were enrolled. For quality control, it was ensured that the surgeries were performed by accredited surgeons, and a central committee reviewed each surgery on the basis of the submitted photographs of the resected field, specimen and skin incision.

Results: For right-sided tumors, the rate of D3 resection was 98.5% (131/133) in the open arm and 100% (136/136) in the laparoscopic arm, and for left-sided tumors, they were 97.9% (322/329) and 98.2% (320/326), respectively. Sufficient length of the resected longitudinal margin was ensured in all cases. The skin incisions made in all the cases were <8 cm as defined in the protocol in laparoscopic arm.

Conclusions: Completion of high quality surgery with D3 resection was confirmed in JCOG0404 by central peer review of photographs of the surgical procedures in addition to operator regulations. This study suggests that the central review of the photo documentation is one of the important tools to assure a quality control of surgical technique in the Phase III randomized-controlled study.

Key words: colorectal cancer – laparoscopy – photograph – quality control – surgery

INTRODUCTION

Quality control is important in randomized-controlled clinical trial for evaluating surgical procedures. There have been no detailed reports of quality assessment of surgical procedures in clinical trials determined by intraoperative photo documentation.

Several large studies have reported that the introduction of total mesorectal excision (TME) (1–5) and complete mesocolic excision (CME) with central vascular ligation (CVL) (6–9) has led to a significant improvement in the prognosis of colorectal cancer. Favorable outcomes in Japanese D3 resection have been reported (10). The percentage of patients undergoing...
mesocolic plane resection for patients who underwent open (OP) resection for colon cancer have been reported to range from 73 to 88% (8), whereas TME rates have been reported to be 66 and 77% for those who underwent OP/laparoscopic (LAP) resection for rectal cancer (11).

JCOG0404 is a randomized controlled trial to evaluate the short- and long-term outcomes of OP and LAP surgery for clinical Stage II/III colon cancer (UMIN-CTR, number C000000105) (12,13). In both arms, resection of the colon by D3 resection was performed according to the Japanese Classification of Colorectal Carcinoma (sixth edition) (14). For quality control, it was ensured that the surgeries were performed by accredited surgeons, and a central review of each surgery was performed on the basis of photographs obtained during the procedure. We assessed the quality of surgery with D3 resection in a randomized controlled trial: JCOG0404 by evaluation of the photo documentation of both OP and LAP surgeries.

**MATERIALS AND METHODS**

**Protocol Digests of JCOG0404**

This multi-institutional, randomized two-arm (OP and LAP) Phase III trial was conducted to evaluate the short- and long-term outcomes of LAP surgery for clinical Stage II/III colon cancer (12,13). Patients were enrolled from 30 centers in Japan. Patients with colon tumors located in the cecum, ascending colon, sigmoid colon and rectosigmoid colon, who were clinically diagnosed as having T3–T4/N0–N2/M0 lesions without involvement of other organs on the basis of colonoscopic and abdominopelvic computed tomographic findings, were eligible. A total of 1057 patients were randomized (OP, 528; LAP, 529; Fig. 1).

This study protocol was approved by the Clinical Trial Review Committee of the JCOG and was also approved and supervised by the institutional review board of each participating hospital. All the patients provided written informed consent. The endpoints, randomization, eligibility criteria and study design have been previously described (12).

**TREATMENT**

As per the trial design, study chair gives certification to surgeons at each participating institution according to the following criteria:

OP surgery: surgeon with an experience of 30 or more OP colectomy.

LAP surgery: surgeon with an experience of 30 or more cases of each OP and LAP colectomy. Additionally, surgeons in LAP arm had to be certified according to the Endoscopic Surgical Skill Qualification System [by the Japan Society of Endoscopic Surgeons (JSES)] (15). In both arms, resection of the colon by D3 lymphadenectomy was performed according to the Japanese Classification of Colorectal Carcinoma (sixth edition; Fig. 2) (14). For right-sided tumors, the vascular pedicles were divided at their origin, and the draining lymph nodes along the superior mesenteric vein were removed (Fig. 3A). For left-sided tumors, removal of lymph nodes at the root of the inferior mesenteric artery was performed along with high ligation or with preservation of the left colic artery and ligation of the root of the superior rectal artery (Fig. 3B and C).
In the LAP arm, the longest wound was measured. When a skin incision > 8 cm was required for the management of intraoperative complications or tumor extension, the surgery was considered as a conversion. The protocol treatment was terminated for the following cases:

(i) Implementation of a curable surgery judged to be impossible because of liver metastases, peritoneal metastases or fourth tier lymph node metastases identified after commencing the surgery.
(ii) Severe invasion to adjacent structures is confirmed after commencing the surgery.
(iii) If the protocol treatment surgeries could not be continued because of intraoperative complications.

PHOTO DOCUMENTATION

The submission of three photographs was required (Fig. 4). We performed a central review of the surgical procedure by evaluating the photographs obtained during the procedure for all the patients. These photographs were evaluated by the study-specific committee for quality control and surgical assessment, and the surgical procedure was discussed at group meetings held twice a year. Either film or digital cameras were used to obtain the photographs. Digital color prints, slide film...
and video tape prints were permitted in the LAP arm and revealed the following:

(i) Operative field: a photograph displaying the extent of lymphadenectomy was obtained between the time after ‘lymphadenectomy and ligation of feeding arteries’ and before ‘reconstruction’ (Fig. 4A).

(ii) Resected specimen: resected specimens were cut along the side opposite to the attachment of the mesocolon to adequately reveal the proximal and distal margins (Fig. 4B).

(iii) Skin incision: the wound with scale just after closure; the longest wound in the LAP arm and the laparotomy wound in the OP arm (Fig. 4C).

The extent of resection, length of wound and the plus/minus allowances of the proximal and distal margins were included on the case report form (CRF).

**CENTRAL PEER REVIEW**

A central peer review committee comprising five surgeons (M.I., F.K., K.S., M.W. and S.Y.), who worked as reviewers of the Endoscopic Surgical Skill Qualification System (by JSES) (14), assessed the submitted photographs.

(i) Lymph node dissection

The extent of lymph node dissection was classified into the following three categories: ‘under D3,’ ‘D3,’ and ‘unevaluable.’ When opinions were divided, the examiners conferred to reach consensus.

(a) Under D3: inadequate to undergo D3 resection (Fig. 5A)

(b) D3: ligated and dissected at the root of the main vessel (Fig. 3)
In subset analysis, we divided D3 into ‘adequate D3’ and ‘beyond D3,’ which are defined below:

(d) Adequate D3: just met the criteria for D3 resection
(e) Beyond D3: extended lymphadenectomy beyond D3.

With regard to the right-sided tumors, the left portion of the superior mesenteric artery was resected. With regard to the left-sided tumors, nearly halfway around the abdominal aorta was exposed for > 5 cm in the long axis direction (Fig. 5B). ‘Proportion of D3’ included ‘beyond D3’ in addition to ‘adequate D3.’

(ii) Proximal/distal margin
A ruler on the photographs was used to measure the length of the proximal/distal longitudinal margins. Negative longitudinal resection margins were confirmed by photo documentation.

(iii) Lengths of skin incisions
A ruler on the photographs was used to measure the lengths of the skin incisions. We confirmed whether the conversion rule was followed and recorded appropriately on CRF by referring to the photo documentation.

STATISTICAL ANALYSIS
Student’s t-test was used to perform the statistical analysis for continuous variables, whereas Fisher’s exact test was used for categorical variables. All P values were two-sided at the 5% significance level, and SPSS Release 20 software (SPSS Inc., Chicago, IL, USA) was used to perform the statistical analyses.

RESULTS

PATIENTS AND PROPORTION OF PHOTO SUBMISSION

In the present study, 1011 (OP, 503; LAP, 508) patients intending to undergo D3 resection, and wherein at least one of the three photographs was submitted were enrolled (Fig. 1). Patients who did not need to undergo D3 resection because of advanced tumors (OP, 21; LAP, 23) and problems with anesthetic management (LAP, 23) were eliminated. The breakdown for photo submission rates in eligible cases were as follows: operative fields (OP, 462/503, 91.8%; LAP, 462/508, 90.9%); resected specimen (OP, 453/503, 90.1%; LAP, 458/508, 90.2%); skin incision (OP, 457/503, 90.9%; LAP, 465/508, 91.5%).

PHOTOGRAPHS OF LYMPH NODE DISSECTION

Proportions of D3 resection in CRF were as follows: OP, 503/503, 100%; LAP, 508/508, 100%.

For the right-sided tumors, the proportion of D3 resection was 98.5% (131/133) in the OP arm and 100% (136/136) in the LAP arm, which was evaluated by central peer review. For the left-sided tumors, the proportion of D3 resection was

Table 1. Lymph node dissection degree

<table>
<thead>
<tr>
<th>Site</th>
<th>Dissection</th>
<th>Open</th>
<th>Laparoscopic</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right-sided tumor</td>
<td>Under D3</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>D3</td>
<td>131 (98.5%)</td>
<td>136 (100%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adequate D3</td>
<td>131 (100%)</td>
<td>136 (100%)</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Beyond D3</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unevaluable</td>
<td>2 (1.5%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
<tr>
<td>Left-sided tumor</td>
<td>Under D3</td>
<td>4 (1.2%)</td>
<td>5 (1.5%)</td>
<td>0.752</td>
</tr>
<tr>
<td></td>
<td>D3</td>
<td>322 (97.9%)</td>
<td>320 (98.2%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adequate D3</td>
<td>319 (99.1%)</td>
<td>308 (96.3%)</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>Beyond D3</td>
<td>3 (0.9%)</td>
<td>12 (3.8%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unevaluable</td>
<td>3 (0.9%)</td>
<td>1 (0.3%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Under D3</td>
<td>4 (0.9%)</td>
<td>5 (1.1%)</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>D3</td>
<td>453 (98.1%)</td>
<td>456 (98.7%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adequate D3</td>
<td>450 (99.3%)</td>
<td>444 (97.4%)</td>
<td>0.034</td>
</tr>
<tr>
<td></td>
<td>Beyond D3</td>
<td>3 (0.7%)</td>
<td>12 (2.6%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unevaluable</td>
<td>5 (1.1%)</td>
<td>1 (0.2%)</td>
<td></td>
</tr>
</tbody>
</table>

OP, open surgery; LAP, laparoscopic surgery; D3, complete mesocolic excision + ligation and dissection at the root of the main vessels; Under D3, inadequate to D3; unevaluable, unable to judge because of defocus or abnormality in color; adequate D3, just sufficient for D3 resection; beyond D3, With regard to the right-sided tumors, the left portion of the superior mesenteric artery was resected. With regard to the left-sided tumors, nearly halfway around the abdominal aorta was exposed for more than 5 cm in the long axis direction.

In subset analysis of cases with D3 completed, we divided D3 into “adequate D3” and “beyond D3.”
97.9% (322/329) in the OP arm and 98.2% (320/326) in the LAP arm, which was evaluated by central peer review (Table 1). With regard to the right sided-tumors, none of the cases were judged as ‘under D3’. With regard to the left sided-tumors, proportion of ‘under D3’ was 1.2% (4/329) in the OP arm and 1.5% (5/326) in the LAP arm.

The cases with ‘beyond D3’ were observed only for left-sided tumors in the subgroup analysis of D3 cases. The ‘beyond D3’ dissection for left-sided tumors was reported more frequently in the LAP arm than in the OP arm (3.8% vs. 0.9%, \( P = 0.020 \); Table 1). A very small number of cases in each arm and site were judged unevaluable because of defocus and abnormality in color.

PHOTOGRAPHS OF MACROSCOPIC RESECTED SPECIMENS

No positive longitudinal resection margins were detected in all the cases by photo documentation. Adequate lengths of longitudinal margins were ensured in every arm and site (Table 2).

PHOTOGRAPHS OF SKIN INCISION

Operators regarded all cases in the LAP arm with >8 cm skin incisions for tumor progression as conversion in the CRF, i.e. we confirmed that the conversion rule was followed and appropriately recorded on CRFs in all cases. In the OP arm, the median length of skin incision was 173 mm for right-sided tumors and 197 mm for left-sided tumors (Table 3). In the LAP arm, the median length of skin incision was 57 mm for both the right- and left-sided tumors.

DISCUSSION

For quality control, the surgeries were performed by accredited surgeons, and a central peer review of each surgery was performed on the basis of photographs obtained during the procedure in JCOG0404. In this study, for surgical quality control and assurance, three photographs including operative field photographs, resected specimen and skin incision were obtained for each surgical procedure. D3 resection was performed for almost all patients (>97.9%) in both arms. In addition, the negative longitudinal resection margins and length of skin incision were assessed as well. In the present study, it was objectively demonstrated that very high quality surgery can in fact be performed by certified surgeons and quality control system to submit surgical photographs reviewed by the central review committee.

With regard to the right-sided tumors, all the cases, except the unevaluable ones, were judged as adequate D3. With regard to the left sided-tumors, the ‘under D3’ dissections were performed at almost same proportion in the OP and LAP arms (1.2 vs. 1.5%). However, the ‘beyond D3’ dissections were higher in the LAP arm than in the OP arm (3.8 vs. 0.9%, \( P = 0.020 \)). Dissection in the LAP surgery might become excessive due to its magnifying but narrow fields of vision. The survival effects and adverse events including urinary dysfunction and impaired intestinal peristalsis of ‘under D3’ or ‘beyond D3’ are currently unknown.

Adequate length of longitudinal margin was ensured not only in the OP arm but also in the LAP arm (16,17). With regard to the skin incision length in the LAP arm, the conversion criterion used in this study (skin incision >8 cm) was confirmed to be followed in all cases by the central review committee.

In this trial, film or digital cameras were used to obtain the photographs. Digital color prints, slide film or printouts from video tape were acceptable for presenting the surgical field in

<table>
<thead>
<tr>
<th>Location of tumor</th>
<th>Procedure</th>
<th>Length of wound (mm) by CRF</th>
<th>Length of wound (mm) by photo documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C, A (OP 130, LAP 132)</td>
<td>PM (mm)</td>
<td>67.0 (47.0—108)</td>
<td>68.0 (48.5—102)</td>
</tr>
<tr>
<td></td>
<td>DM (mm)</td>
<td>89.5 (66.8—115)</td>
<td>73.0 (55.3—107)</td>
</tr>
<tr>
<td>S (OP 200, LAP 220)</td>
<td>PM (mm)</td>
<td>72.5 (52.0—94.5)</td>
<td>64.0 (48.0—90.0)</td>
</tr>
<tr>
<td></td>
<td>DM (mm)</td>
<td>57.5 (44.0—75.8)</td>
<td>58.0 (41.0—88.3)</td>
</tr>
<tr>
<td>RS (OP 123, LAP 106)</td>
<td>PM (mm)</td>
<td>76.0 (58.0—115)</td>
<td>76.5 (55.0—107)</td>
</tr>
<tr>
<td></td>
<td>DM (mm)</td>
<td>30.0 (22.0—45.0)</td>
<td>33.0 (22.0—46.0)</td>
</tr>
</tbody>
</table>

Values are reported as mean ± standard deviation (range). CRF, case report form.

Table 3. Length of wound

C, cecum; A, ascending colon; S, sigmoid colon; RS, rectosigmoid colon; PM, length of proximal margin; DM, length of distal margin.

For quality control, the surgeries were performed by accredited surgeons, and a central peer review of each surgery was performed on the basis of photographs obtained during the procedure in JCOG0404. In this study, for surgical quality control and assurance, three photographs including operative field photographs, resected specimen and skin incision were obtained for each surgical procedure. D3 resection was performed for almost all patients (>97.9%) in both arms. In addition, the negative longitudinal resection margins and length of skin incision were assessed as well. In the present study, it was objectively demonstrated that very high quality surgery can in fact be performed by certified surgeons and quality control system to submit surgical photographs reviewed by the central review committee.

With regard to the right-sided tumors, all the cases, except the unevaluable ones, were judged as adequate D3. With regard to the left sided-tumors, the ‘under D3’ dissections were performed at almost same proportion in the OP and LAP arms (1.2 vs. 1.5%). However, the ‘beyond D3’ dissections were higher in the LAP arm than in the OP arm (3.8 vs. 0.9%, \( P = 0.020 \)). Dissection in the LAP surgery might become excessive due to its magnifying but narrow fields of vision. The survival effects and adverse events including urinary dysfunction and impaired intestinal peristalsis of ‘under D3’ or ‘beyond D3’ are currently unknown.

Adequate length of longitudinal margin was ensured not only in the OP arm but also in the LAP arm (16,17). With regard to the skin incision length in the LAP arm, the conversion criterion used in this study (skin incision >8 cm) was confirmed to be followed in all cases by the central review committee.

In this trial, film or digital cameras were used to obtain the photographs. Digital color prints, slide film or printouts from video tape were acceptable for presenting the surgical field in

Table 2. Length of proximal/distal margins of resected specimens measured on submitted photographs. Median (interquartile range)
LAP surgeries. Proportion of photo submission was quite high and almost all of the submitted photographs were of sufficient image quality to allow good assessments.

In notable randomized controlled trials that have compared OP and LAP surgeries, the protocols required that every surgeon had experience of performing at least 20 LAP-assisted resections (11,18,19). In the COLOR trial, a videotape of a LAP colectomy was submitted to assess techniques before entering the trial (18). In the COST trial, LAP procedures were video recorded and members of the executive committee audited a randomly selected of the first 500 cases (19). Few clinical trials investigating surgical techniques have mandated that photographs be submitted for quality control of surgery (20–22). The two independent trials demonstrated whether photo prints or video images were of sufficient quality to determine whether critical view of safety was achieved in LAP cholecystectomy (23,24). However, there have been no detailed reports of quality assessments of colorectal cancer surgery determined by photo documentation. In addition, there have not been any definitive clinical studies that have compared dissection quality using intraoperative photographs between OP and LAP surgeries.

Recently, several large studies have reported that introduction of TME (1–5) and CME with CVL (1,6–9) has led to a significant improvement in the prognosis of colorectal cancer. The Japanese Society for Cancer of the Colon and Rectum recommends that the extent of lymph node dissection to be performed during colorectal cancer surgery is determined based on the pre-operative clinical findings or on the extent of lymph node metastasis and depth of wall invasion by the tumor observed intraoperatively (25). If lymph node metastasis is suspected based on the pre-operative/intraoperative diagnostic findings, D3 resection is performed. Even though no lymph node metastasis is suspected based on the pre-operative/intraoperative diagnostic findings, T3–T4 tumors are suitable candidates for D3 resection (26). The present study objectively demonstrated that very high quality surgeries were in fact performed by certified surgeons in both OP and LAP arms, who were required to submit photographs of the surgical procedure. Mandatory photo submission was considered to act as a reminder to surgeons for doing surgical procedures according to the protocol.

The limitation of this study includes the cases wherein no photographs were submitted. The reasons for non-submission were that the surgeons forgot to obtain photographs or the camera malfunctioned. Another limitation is a lack of follow-up evaluation. The contribution of lymph node dissection to the prognoses will be assessed by analysis of long-term survival in 2014.

In JCOG0404, high quality surgery with adequate D3 resection was objectively confirmed to be successfully completed by certificated surgeons and central review of photographs obtained during the procedures. This study suggests that the central review of the photo documentation is one of the important tools to assure a quality control of surgical technique in the Phase III randomized-controlled study.

Acknowledgements
We wish to thank Ai Sato, MS, for her expert illustrating assistance.

Funding
This work was supported by National Cancer Centre Research and Development Fund, Grant-in-Aid for Cancer Research, Health and Labour Sciences Research Grant for Clinical Cancer Research from the Ministry of Health, Labour and Welfare of Japan.

Conflict of interest statement
None declared.

References


25. Emous M, Westerterp M, Wind J, Eerenberg JP, van Geloven AA. Registering the critical view of safety: photo or video? 

26. Plaisier PW, Pauwels MM, Lange JF. Quality control in laparoscopic cholecystectomy: operation notes, video or photo print? 


34. Toyota S, Ohta H, Anazawa S. Rationale for extent of lymph node dissection for right colon cancer. 

