Key points of tumor-free operation in laparoscopic resection for colorectal cancer

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Abstract: Tumor-free operation is an important principle of oncological surgery for colorectal cancer. Laparoscopic resection of colorectal cancer should also adhere to the tumor-free operation principle. Iatrogenic dissemination of cancer cells into the abdominal cavity during the laparoscopic resection of colorectal cancer is possible and should be paid attention by the surgeons. In order to reduce the rate of peritoneal seeding, the tumor-free operation principle should be implemented throughout the whole laparoscopic procedure. The steps we should follow as a routine practice include: (I) proper management of trocars and the pneumoperitoneum; (II) no-touch and protection of the tumor; (III) protection of the incision wound; (IV) priority of the high vascular ligation; (V) *en bloc* resection of the primary tumor and regional lymph nodes; (VI) sharp resection of the tumor; (VII) complete mesocolic excision (CME) of colon cancer and total mesorectal excision (TME) of rectal cancer; (VIII) replacement of the surgical instrument and gloves after the removal of the tumor; (IX) satisfactory scrub and irrigation; and (X) selective intraperitoneal chemotherapy.

Keywords: Colorectal cancer; laparoscopic resection; tumor-free operation

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In the current age of minimally invasive surgery, laparoscopic technique has accomplished a major progress in the treatment of colorectal cancer (1-3). As with conventional open surgery, laparoscopic surgery for colorectal cancer is also required to follow the principles of tumor-free operation to reduce the risk of iatrogenic dissemination of cancer cells on the peritoneal surface. In the early 1990s, there was reports of port site recurrence up to 21% when the laparoscopic resection for colorectal cancer started initially (4). However, with the increasing maturity of laparoscopic procedure and highly emphasizing the importance of the principle of tumor-free operation, the incidence of port site metastases has significantly decreased to below 3% (5-7).

Reports of port site metastasis have stimulated clinical and basic research, attempt to explain the possible mechanisms involved in the pathogenesis of peritoneal dissemination in laparoscopic surgery for colorectal cancer (8-10). The possible mechanisms of peritoneal seeding of colorectal cancer cells in laparoscopic procedure include the following aspects: (I) the tumor penetrates the serosa, escapes from the primary tumor and spreads in the peritoneum; (II) the excessive manipulation of tumor during laparoscopic surgery; (III) tumor cells spread during lymphadenectomy in patients with lymphatic invasion or lymph node involvement; (IV) the hemorrhage during the surgery for colorectal cancers with vascular invasion. These shedding cancer cells enter the abdominal cavity, enwrapped by the fibrin and blood clots, inducing the peritoneal implantation

with the effect of immunologic responses. The exploring and understanding of the mechanisms of peritoneal dissemination of colorectal cancer cells provides clues for surgeons to take essential measures to reduce the cancer cell dissemination.

In order to reduce the potential peritoneal dissemination of cancer cells, the following three principles should be obeyed by surgeons:

(I) The principle of multidisciplinary comprehensive treatment. For colorectal cancer patients with high risks of metastasis, such as primary carcinoma invading the surrounding organs (T4), lymph node involvement and positive resection margin, perioperative neoadjuvant and adjuvant chemotherapy or chemoradiotherapy should be taken into consideration.

(II) The principle of tumor-free operation. A set of effective measures of tumor-free operation performed in the open surgery can also be applied in the laparoscopic surgery.

(III) Awareness of the specificity of laparoscopic operation. Strengthen the management of pneumoperitoneum during the laparoscopic surgery.

The principle of tumor-free operation should be kept in mind by surgeons, which runs through the whole process of laparoscopic operation. The following are key points of tumor-free operation in laparoscopic resection for colorectal cancer.

Operation associated with trocars

Placement of trocars

Proper placement of trocars to minimize tissue trauma is important. A suitable size of puncture hole made with trocar helps to perform trocar fixation to prevent trocars slipping off and CO_2 leakage around trocars. Caution should be exercised during the operation to reduce the risk of bleeding.

Removal of trocars

Before the trocar removal, the gas in the trocar sheath should be exhausted first, then the trocar can be removed. In that case, it can reduce the incidence of port site recurrence caused by the "chimney effect" (the chimney effect refers to the increase in the number of tumor cells at the port sites caused by leakage of gas along the trocars) (11).

The pressure of pneumoperitoneum

Appropriate pneumoperitoneum pressure is essential in the laparoscopic operation. A carbondioxide pneumoperitoneum at 12–15 mmHg is most commonly used which provides good laparoscopic visualization and sufficient working space (12). In the premise of obtaining sufficient operation space, it's recommended to choose a relatively low pressure of pneumoperitoneum.

The principles of laparoscopic exploration

Laparoscopic exploration should follow the principle of "from far to near", and explore the tumor in the end.

The principles of tumor resection

Protection of the tumor surface

It is recommended for carcinomas with serosa invasion to isolate serous surface by using gauze or blocking glue, in an attempt to prevent the shedding of cancer cells.

No-touch technique

"No-touch" principle should be followed throughout the operation: (I) minimal or even no touch with tumor; (II) avoidance of squeezing the tumor. The following four points should be complied with to the best of the surgeons' efforts: (I) minimum frequency of tumor touch; (II) minimum duration of tumor touch; (III) latest time of tumor touch; and (IV) preferably no touch with tumor.

Use protective bags to retrieve specimen

For the specimens resected from different regions, each specimen can be placed in a protective bag, which can be taken out together when the resection of all lesions and tissues and organs involved is accomplished. For example, in the laparoscopic resection of rectal cancer combined with bilateral lateral lymph nodes, the preferential removal of lateral lymph nodes can be put into a protective bag (gloves or disposable protective bags, etc.), which can be taken out together with other resected specimens(the other side of lateral lymph nodes and the rectal cancer).

Performing high vascular ligature

Once the resection scope is determined, central ligation

of main supplying vessels first may reduce the risk of hematogenous dissemination of cancer cells (13). A high main reflux vein ligation is recommended if circumstances permit. For instance, in the radical resection of rectal carcinoma, surgeons can cut off the inferior mesenteric vein first, then cut off the main artery (the inferior mesenteric artery or superior rectal artery) and finally perform tumor resection.

Regional lymph node dissection

Current principle of colorectal cancer surgery is en bloc resection of the primary tumor with regional lymph nodes and all grossly suspected or involved lesions should be removed during operation (14). The operation of single lymph node resection should be avoided as possible. As it should be, a biopsy or resection of lymph nodes outside the drainage area is acceptable.

Sharp dissection

Sharp dissection is conducive to reducing the traction and squeeze involved in handling of tumor. To carry out accurate sharp dissection needs to maintain good tension in the operation. Nevertheless, some experts suggest that sharp dissection and blunt dissection be combined in laparoscopic surgery due to its particularity, in that case, the operation will be more secure and easier to master from a technical aspect. However, in terms of the principles of oncology, sharp dissection may be more reasonable and is proposed to be performed in laparoscopic surgery.

Removing the mesocolon or mesorectum as one package

Total mesorectal excision (TME) and complete mesocolic excision (CME) have become essential principles of radical resection for colorectal cancer (15,16). The concept of membrane anatomy has been increasingly emphasized by surgeons. TME/CME prevents the shedding of cancer cells by en bloc resection of a primary tumor and mesorectum/mesocolon as one package, contributing to the improvement of outcomes (15,16).

Minimizing haemorrhage

Only by minimizing haemorrhage can surgeons obtain a clear surgical field to ensure laparoscopic operation smooth and successful. If there are free cancer cells in circulatory system or vascular involvement, haemorrhage may also result in the spillage of cancer cells into the peritoneal cavity and onto the surfaces traumatized during surgery. Therefore, to minimize haemorrhage by operating carefully and suctioning blood clots promptly and thoroughly can also help to reduce the spread of cancer cells.

Instruments cleaning and glove replacement

The instruments should be cleaned or even replaced if there's obvious contact with tumor. After the removal of tumor specimens, the gloves should be replaced and the resection margin should be washed before the intestinal reconstruction. Rinsing the tip of instruments if they touch the tumor before they are reintroduced into the abdominal cavity (13). Betadine solution is recommended since it has been confirmed to be tumoricidal by many investigators (17).

Scrub and irrigation

The procedure of scrub and irrigation

When specimen is removed out of the abdominal cavity, the resection margin and surgical field should be irrigating *in vivo* or *in vitro*. The cut edge of intestine is proposed to be scrubbed with iodophor gauze or gauze ball before the anastomosis of intestines, aiming to avoid cancer cells shedding into the anastomosis. Anastomosis site needs irrigating again when the anastomosis is completed. Besides, the abdominal auxiliary incision wound and puncture port-site should also be irrigated with iodophor and water. The careful suction of blood clots and fat blocks is also needed.

The application of irrigation fluid

There are many arguments about the application of irrigation fluid in clinical practice. In addition to cleaning effect, ideal irrigation fluid needs to be capable of destroying cancer cells. In general, double distilled water (DDW) is better than normal saline (NS). Immersion in 43 ℃ DDW is better than that in DDW at ambient temperature. Immersion in 1:2,000 chlorhexidine at ambient temperature lasting for 3 minutes is equal to that in 43 ℃ DDW lasting for 10 minutes. Therefore, irrigation with 1:2,000 chlorhexidine at ambient temperature after the removal of specimens is a relatively simple and effective method. However, there is no supply of chlorhexidine in

many hospitals, as a result, chlorhexidine is replaced by diluted iodophor. Diluted iodophor is effective disinfectant confirmed by many investigators (17). The 0.5–1% diluted iodophor is widely used for disinfection of skin and instruments. It is noteworthy that the surgical area should be irrigated with sufficient NS (500–1,000 mL) after irrigation with chlorhexidine or diluted iodophor.

Incision protection

Incision protection must be done immediately after entering the abdominal cavity in open surgery. Different from open surgery, the auxiliary incision from which specimen is taken out is created in laparoscopic surgery when the tumor is resected or is about to be removed. The incision in laparoscopic surgery also needs protection in order to reduce the incidence of specimens touching incision leading to tumor cell implantation. There are many products and ways for incision protection. The incision protection sleeve with sealing cover is recommended.

Selective intraperitoneal chemotherapy

Intraperitoneal chemotherapy is not the standard treatment for colorectal cancer at present. But intraperitoneal chemotherapy, especially hyperthermic intraperitoneal chemotherapy (HIPEC), may reduce the risk of peritoneal metastasis for colorectal cancer patients with the following high risk factors: (I) serosa invasion (T3/T4); (II) mucinous carcinoma or signet ring cell cancer; (III) positive resection margins; (IV) tumor rupture; or (V) intestinal perforation. A small sample study conducted by Sammartino *et al.* indicated that HIPEC seems to achieve a good local control in preventing peritoneal dissemination without significant increase of the perioperative morbidity (18). Mitomycin, cisplatin and oxaliplatin are chemotherapeutics commonly used in HIPEC. HIPEC is carried out lasting 30–90 minutes at a temperature of 42–43 ℃ (19,20). The time of HIPEC lasting varies in different chemotherapeutic drugs.

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Footnote

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/ales.2016.10.06). The authors have no conflicts of interest to declare.

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