Original Article

Using a Simple Surgical Skill to Forecast a Safe Distal Resection Margin for Low Anterior Resection of Rectal Cancer

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Key Words
Surgical distal resection margin;
Low anterior resection;
Rectal cancer

Purpose. This study was designed to forecast a safe distal resection margin while performing low anterior resection of rectal cancer.
Methods. We included patients with stage I to VI rectal cancer who had been operated on by a single surgeon at Kaohsiung Veterans General hospital between October 2012 and June 2013. We created a mark at the lower border of the tumor. Then, we measured the length (for the upper rectum, 3 cm; for the mid-low rectum, 2 cm) from the lower border in anatomical position as a resection mark. We cut the rectum from the resection mark and then removed the specimen. We measured the distal resection margin of the specimen. We followed the distal resection margin of specimens in pathology reports. We compared the difference between these distal resection margins.
Results. Low anterior resection was performed for 70 patients during the study. Other surgeons treated 38 patients who were excluded. Two patients were excluded because they had received neoadjuvant chemoradiation therapy. Totally, 30 patients were included in the study (25 men and 5 women). Seventeen tumors were located in the upper rectum and 13 tumors in the mid-low rectum. The mean distal resection margin (in vivo) was 36.3 ± 8.50 mm. The mean distal resection margin (pathology) was 21.0 ± 9.37 mm. The rate of specimen shrinkage was 44.1%.
Conclusion. By measuring the distal resection margin of low anterior resection, we can obtain R0 resection and forecast at least a 1-cm safe pathologic distal resection margin.
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Colorectal cancer is diagnosed in more than 10,000 people each year in Taiwan.[1] Adenocarcinoma of the rectum accounts for approximately 30% of all colorectal malignancies.[2] Surgeons still face a challenge to obtain a histologically circumferential resection margin and distal resection margins (DRM) to yield a curative R0 resection. In recent years, sphincter-preserving procedures and coloanal anastomosis have become widespread procedures. The common methods used are open surgery, laparoscopic surgery, and robotic surgery. Thus, it is important to acquire a safe DRM. The National Comprehensive Cancer Network guidelines (NCCN guidelines) state that there should be a surgical DRM of 4 to 5 cm for partial me-

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sorectal excision in patients undergoing surgery for treatment of upper rectal cancer and there should be a surgical DRM of 1 to 2 cm for total mesorectal excision in patients undergoing surgery for treatment of low rectal cancer.[3] According to the Japanese Classification of Colorectal Carcinoma, the DRM should be 2 cm from the distal edge of the tumor for lower rectal cancer, and 3 cm for upper rectal cancer.[4] There is a controversy over what constitutes a safe distal tumor-free margin for rectal cancer. In a recent report, there were no differences in local and systemic recurrence rates in patients who received neoadjuvant or adjuvant chemoradiotherapy with the DRM ≤ 0.5 and > 0.5 cm.[5] However, if patients did not receive radiotherapy, a safe margin of 10 mm is still recommended.[6] The aim of this study was to accurately predict a safe histological DRM during surgery.

Materials and Methods

Patients

The clinical study initially included all patients with stage I to IV rectosigmoid or rectal cancer who were operated on at Kaohsiung Veterans General hospital in Kaohsiung, Taiwan between October 2012 and June 2013. The cancer stage was defined according to the 7th edition of the International Union Against Cancer TNM classification. The rectal tumor is defined as upper rectal tumor 10-15 cm from anal verge, the middle rectal tumor 5-10 cm from anal verge, and the low rectal tumor below 5 cm from anal verge. Inclusion criteria were confirmed adenocarcinoma on histological examination before operation and no pre-operative chemotherapy or radiotherapy. Exclusion criteria were anal cancer, recurrent cancer, secondary neoplasm, previous neoadjuvant chemotherapy because of presumptive treatment-related changes in cancer stage, and operation by another surgeon.

Surgical procedure

Low anterior resection with total mesorectal excision was performed for all patients. After mobilization of the rectum, we created a linear mark on the rectum at the lower limit of the tumor as the first mark, with an electrosurgical switching pencil (Fig. 1). We created another linear mark (more than 30 mm below the lower limit of tumor for upper rectal cancer and more than 20 mm below the lower limit of tumor for mid-low rectal cancer) in anatomical position as a resection mark (Fig. 1). We measured and recorded the length between the two marks as the first DRM. We applied the thoracoabdominal stapler below the incision mark. We excised the rectum from the excision mark and then removed the specimen. We incised the specimen, and then measured and recorded the length between the lower limit of the tumor and the cut-end on the intra-luminal side as the second DRM. We recorded the third DRM as per the official histopathology report. The distal margin was measured three times: 1) an in vivo measurement during the operation by the surgeon; 2) an ex vivo measurement after removal of specimen by the surgeon, and 3) an ex vivo measurement after fixation by the pathologist.

Results

A total of 70 patients received low anterior resection with total mesorectal excision during the period of the study. Thirty-eight patients were excluded as they were treated by other surgeons. Two patients were

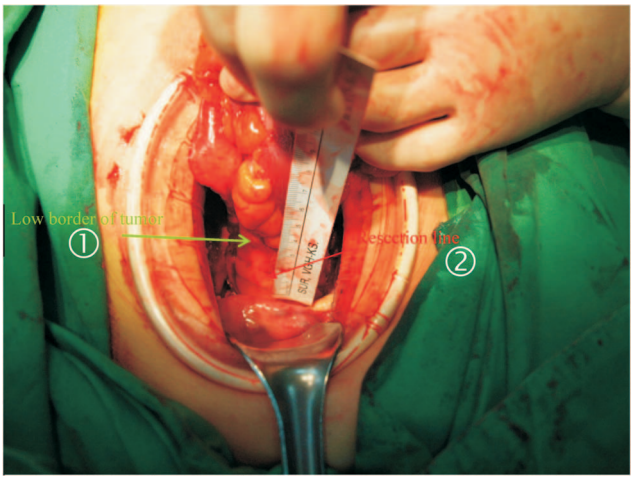

Fig. 1. Surgical technique. ① Low border of tumor; ② resection line.

excluded as they had received neoadjuvant combination chemoradiation therapy. A total of 30 patients (25 men and 5 women; mean age, 60.25 years [standard deviation, 11.44 years; range, 38-83 years) received low anterior resection with total mesorectal excision. The tumor was located at the upper rectum in 17 patients and in the mid-low rectum in 13 patients. Twelve patients had preoperative stage I tumors; 6 patients had preoperative stage II tumors; 10 patients had preoperative stage III tumors; and 2 patients had preoperative stage IV tumors. In 2 patients, the cancer stage changed after the operation (up-staged from stage II to stage III). Twenty-eight patients had histological type of moderately differentiated adenocarcinoma, 1 had histological type of poorly differentiated adenocarcinoma, and 1 had histological type of mucinous adenocarcinoma. Three patients experienced post-operative complications (2 patients had post-operative ileus and 1 patient had leakage of anastomosis). Seven patients received colostomy (6 patients received protective T-loop colostomy and 1 patient received T-loop colostomy due to leakage of anastomosis). The clinicopathological data are summarized in Tables 1 and 2. The mean DRM (in vivo) was 36.4 ± 8.69 mm. The mean DRM (ex vivo) was 28.1 ± 10.93 mm. The mean DRM (pathology) was 21.0 ± 9.65 mm. The rate of specimen shrinkage while comparing the DRM in vivo and ex vivo was 23.3 ± 20%. The rate of specimen shrinkage while comparing the DRM in vivo and on pathology was 43.2 ± 25.1%. The rate of specimen shrinkage while comparing the DRM ex vivo and on pathology was 80 ± 28.7%. The data are summarized in Table 2.

Table 1. Clinicopathological characteristics and post-operative results of 30 patients treated with low anterior resection

Categorical variables*	No. of patients (%)
Sex	
Male	25 (83.3)
Female	5 (16.7)
Cell type	
Adenocarcinoma, MD	28 (93.3)
Adenocarcinoma, PD	1 (3.3)
Mucinous carcinoma	1 (3.3)
Other	0 (0)
Tumor location	
Upper rectum	17 (56.7)
Mid-low rectum	13 (43.3)
Pre-operative stage	
I	12 (40)
II	6 (20)
III	10 (33.7)
IV	2 (6.7)
Post-operative stage	
I	12 (40)
II	4 (13.3)
III	12 (40)
IV	2 (6.7)
Complication	3 (10)
Post-operative ileus	2 (6.7)
Leakage of anastomosis	1 (3.3)
Colostotomy	
Protective colostomy	6 (20)
Leakage	1 (3.3)

SD standard deviation, MD moderately differentiated, PD poorly differentiated.
* Values are numbers with percentages in parentheses unless otherwise indicated.
** Values are mean ± standard deviation.

Table 2. Results of distal resection margin

Categorical variables*	Length (mm)
In vivo	
Distal margin	36.3 ± 8.50
Ex vivo	
Distal margin	27.9 ± 10.66
Pathology	
Distal margin	21.0 ± 9.37
Division of distal margin (in vivo and ex vivo)	8.4 ± 8.07
Division of distal margin (in vivo and pathology)	16.0 ± 11.04
Division of distal margin (ex vivo and pathology)	7.6 ± 11.04
Shrinkage of distal margin	**Rate (%)**
Ex vivo/in vivo	23.1
Pathology/in vivo	44.1
Pathology/ex vivo	27.3

* Values are mean ± standard deviation.

Discussion

DRM should be measured by the surgeon

When is the best time for distal margin assessment, and should it be done by the surgeon or the pathologist? The surgeon can measure the length of DRM on the fresh specimen in vivo or ex vivo before any tumor shrinkage. The pathologist can measure the length of DRM before or after fixation of the speci-

men.[7] The 1-cm rule refers to margins measured by surgeons using fresh specimens.[8] Emmanuel et al. reported that the distal margin can be assessed intra-operatively and that the surgeon might be the best person to assess the DRM.[7] In our study, the same surgeon measured and recorded the DRM in vivo and ex vivo. Thus, in this way, we can decrease the chances of personal errors of measurement.

Shrinkage of specimens

When the specimen has been removed, shrinkage of the specimen makes it difficult to measure the accurate length of DRM.[7] Goldstein en al. showed that approximately 70% of the shrinkage occurred during the first 10 to 20 minutes after removal, and 30% occurred after fixation.[9] Other reports showed that tissue shrinkage from formalin fixation in general might be around 10-30%.[10,11] Therefore, a DRM of 2-3 cm in vivo is about 1-1.5 cm ex vivo after fixation without pinning.[12] In our study, we determined that the rate of specimen shrinkage compared with DRM in vivo and pathology was 43.2 ± 25.1%. This result was approximately similar to previous studies.

Distal spread of the tumor and the 1-cm rule

The distal spread of the tumor is a prognostic factor of local recurrence. Goligher et al. detected distal spread in only 6.5% of 1500 specimens examined, and only 2% of rectal cancers showed distal spread of more than 2 cm.[13] Moore et al. reported that distal intramural spread (DIS) occurs in only 4% of patients with rectal cancer. DIS exceeds 1 cm in only 2 to 5% of cases and exceeds 2 cm in 1 to 2% of cases.[14] Other studies have also showed that DIS is rare and is found in 3.8% to 10% of rectal cancer specimens by careful pathologic dissection.[6,15] The 1-cm rule is based on the fact that DIS > 1 cm occurs in a substantial proportion of patients.[8] Komori et al. collected and analyzed the pathology reports of 629 patients. They reported that the frequency of discontinuous spread was 1.0% for well-differentiated adenocarcinomas, 8.4% for moderately differentiated adenocarcinomas, 52.9% for poorly differentiated adenocarcinomas, and 81.5% for mucinous adenocarcinomas. They also reported that the average length of distal spread was 0.5 ± 1.3 mm for well-differentiated adenocarcinomas, 0.7 ±1.8 mm for moderately differentiated adenocarcinomas, 2.7 ± 2.4 mm for poorly differentiated adenocarcinomas, and 10.0 ± 9.5 mm for mucinous adenocarcinomas. However, mucinous adenocarcinoma accounts for approximately 4.3% of all pathologic diagnosis. If the preoperative pathologic report indicates a poorly differentiated adenocarcinoma or mucinous adenocarcinoma, the surgical DRM must be longer and abdominoperineal resection should be considered.[16] In our study, only 1 (3.3%) patient's pathology diagnosis was mucinous adenocarcinoma. We determined that the mean DRM (pathology) was 21.0 ± 9.37 mm via this skill. Most of our patients who were operated on had a sufficiently safe DRM. If permanent pathology report showed histology of mucinous adenocarcinoma or evidence of tumor with distal spread, we can give adjuvant radiotherapy or chemotherapy to reduce the rate of local recurrence.

Other methods to determine the distal safety margin

Chen et al. showed that a transanal technique with purse string suture ligation at least 2 cm away from the tumor as guide during operation. They obtained a pathologic distal resection margin of 24.9 mm.[17] In another study, the authors examined intra-operative frozen sections to determine the distal safety margin and showed that a distal margin > 5 mm ensured a free margin at the final pathology.[18] Transanal endoscopic microsurgery and transanal minimally invasive surgery (TAMIS) with total mesorectal excision were used to determine a distal safety margin for low rectal cancer.[19-21] Knol et al. showed that the distal resection margin was 19.4 ± 10.4 mm when TAMIS with total mesorectal excision was performed.[21] Another study showed the result of distal mean resection margin was 11.2 mm.[22] In the future, transanal endoscopic microsurgery or TAMIS with total mesorectal excision may be performed extensively to increase the possibility of sphincter-preserving resection.

There are several limitations to our study. The first

and the foremost limitation is a small dataset (30 patients). The second limitation is that we focused on a single surgeon's experience, which could not be compared with other surgeons. The third limitation was there was no long-tern follow-up, so we could not make sure that this method will decrease the rate of local recurrence. However, none of the patients had any local recurrence during a follow up interval of 18 to 30 months.

Conclusions

From this study, we marked distal resection margin in low anterior resection (for the upper rectum, 3 cm; for the mid-low rectum, 2 cm) in advance; we can obtain a R0 resection and forecast at least 1 cm safe pathological distal resection margin. We were able to make a final decision regarding the operative procedure (low anterior resection or abdomino-perineal resection) to increase the possibility of sphincter-preserving resection.

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原　著

使用一個簡單手術技巧在直腸癌低前位切除手術中預測安全的腫瘤遠端手術切除長度

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目的　使用簡單的手術技巧在大腸直腸癌低前位切除手術中預測安全的腫瘤遠端手術切除範圍。

方法　從 2012 年 10 月至 2013 年 6 月間，收集第一期至第四期直腸癌患者在高雄榮民總醫院外科部大腸直腸外科由同一位醫師開刀的病例。在手術當中，我們將直腸擺放至正常位置並再腫瘤下方邊緣處利用電刀製造一個記號。我們在距離記號下方在製造一個手術切除範圍的記號 (高位直腸癌至少距離腫瘤下緣 3 公分、中低位直腸癌至少距離腫瘤下緣 3 公分) 並紀錄遠端邊緣長度。之後切除腫瘤後，立即切開直腸標本，由腸道內部測量並紀錄腫瘤下緣至切口處長度。最後再由病理報告查詢並紀錄病理報告中腫瘤的遠端邊緣長度。我們比較術中、術後及病理的遠端邊緣長度的差異。

結果　共 70 直腸癌病患在研究期間內接受手術，38 位病患由科內其他醫師手術，2 位病換因接受過手術前化學並放射線治療遭到剔除，最後共 30 位病患 (25 位男性、5 位女性) 被收錄於研究中。17 個腫瘤位於高位結腸，13 個腫瘤位於中低位結腸。手術中測量得到的活體平均遠端切除長度為 36.3 ± 8.50 mm，病理報告中的平均遠端切除長度為 21.0 ± 9.37 mm。平均檢體收縮比率為 44.1%。

結論　依本研究的解果，我們預先於高位直腸癌腫瘤邊緣到切口處預留至少三公分範圍，而低位直腸癌腫瘤邊緣到切口處預留至少兩公分，可以在獲得病理學上完全切除及至少一公分病理遠端切除長度。

關鍵詞　手術遠端切除長度、低前位切除手術、直腸癌。