

CLINICAL SCIENCE

Abdominoperineal resection does not decrease quality of life in patients with low rectal cancer

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PURPOSE: Issues related to body image and a permanent stoma after abdominoperineal resection may decrease quality of life in rectal cancer patients. However, specific problems associated with a low anastomosis may similarly affect quality of life for patients undergoing low anterior resection. The aim of this study was to compare quality of life of low rectal cancer patients after undergoing abdominoperineal resection versus low anterior resection.

METHODS: Demographics, tumor and treatment characteristics, and prospectively collected preoperative quality-of-life data for patients undergoing low anterior resection or abdominoperineal resection for low rectal cancer between 1995 and 2009 were compared. Quality of life collected at specific time intervals was compared for the two groups, adjusting for age, body mass index, use of chemoradiation, and 30 days postoperative complications. The short-form-36 questionnaire was used to determine quality of life.

RESULTS: The query returned 153 patients (abdominoperineal resection = 68, low anterior resection = 85) with a median follow-up of 24 (3-64) mo. The after abdominoperineal resection group had a higher mean age (63 ± 12 vs. 54 ± 12 , $p < 0.001$) and more American Society of Anesthesiologists classification 3/4 patients (65 percent vs. 43 percent, $p = 0.03$) than low anterior resection. Other demographics, tumor stage, use of chemoradiation, overall postoperative complication rates, and quality-of-life follow-up time were not statistically different in both groups. Patients undergoing abdominoperineal resection had a lower baseline short-form-36 mental component score than those undergoing low anterior resection. However, 6 mo after surgery this difference was no longer statistically significant and essentially disappeared at 36 mo after surgery.

CONCLUSION: Patients undergoing abdominoperineal resection for low rectal cancer have a similar long-term quality of life as those undergoing low anterior resection. These findings can help clinicians to better counsel patients with low rectal cancer who are being considered for abdominoperineal resection.

KEYWORDS: Rectal cancer; Quality of life; Abdominoperineal resection; Low anterior resection.

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INTRODUCTION

An increasing number of people are diagnosed with rectal cancer in the United States each year, with approximately 50,000 new cases expected for the year 2010.¹ The past two decades have been marked by advances in rectal cancer treatment, particularly the widespread adoption of total mesorectal excision²⁻⁴ and use of neoadjuvant chemoradiation,^{5,6} both of which have improved local control, whereas modern adjuvant chemotherapy regimens have increased overall and disease-free survival.⁷⁻⁹ Therefore, gaining a better understanding of the quality of life (QOL) of rectal cancer survivors has become a matter of paramount importance.

The surgical treatment options for patients with low rectal cancer (i.e., less than 5 cm from the anal verge) include low

anterior resection (LAR) or abdominoperineal resection (APR).⁹⁻¹¹ An APR is the procedure of choice when a distal margin of clearance cannot be obtained or the sphincter complex is invaded by the tumor, whereas LAR is indicated for all other low rectal cancers^{10,12,13} or LAR is technically feasible but may be associated with poor functional outcomes because of sphincter dysfunction. It is a common perception that issues related to body image and a permanent stoma after APR have a negative impact on QOL; consequently, this procedure is avoided whenever possible.¹⁴ Recent studies have shown, however, that specific problems associated with a low anastomosis may similarly affect QOL of patients with low rectal cancer who undergo LAR.^{15,16} Therefore, the aim of this study is to compare the overall QOL in low rectal cancer patients undergoing either APR or LAR.

PATIENTS AND METHODS

This study was approved by the Cleveland Clinic Institutional Review Board. A single center, prospectively

maintained, colorectal cancer database was queried for patients with low rectal cancer who underwent curative intent APR or LAR between January 1, 1995, and January 1, 2009. Low rectal cancer was defined as cancer where the tumor was located no more than 5 cm from the anal verge, as detected by rigid proctoscopy. Only patients with documented preoperative overall QOL assessment were included.

APR and LAR patients were compared with respect to demographics, preoperative morbidity, treatment characteristics, tumor stage, and overall QOL. Overall QOL was assessed through the validated short-form 36 questionnaire (SF-36), given up to 30 days prior to surgery, then at 6-, 12-, and 36-mo intervals postoperatively.

SF-36, a widely used QOL questionnaire, includes 36 items selected from a larger pool of items originally used in the RAND Corporation's Medical Outcomes Study.¹⁷ Using multi-item scales of 35 items, it assesses eight health concepts as follows:

1. Physical functioning (10 items)
2. Role limitations caused by physical health problems (3 items)
3. Role limitations caused by emotional problems (3 items)
4. Social functioning (2 items)
5. Emotional well-being (5 items)
6. Energy/fatigue (4 items)
7. Pain (2 items)
8. General health perceptions (5 items)

A final item assesses the patient's perception of changes in health status over the last 12 mo.

In order to ensure the honesty and accuracy of patient answers, patients were given the opportunity to fill out the preoperative questionnaire privately in the clinic or to take the questionnaires home with them, to complete and return by mail before the date of their surgery. The follow-up questionnaires were mailed to the patients' homes, for them to complete at their convenience.

Statistical analysis

Categorical variables were expressed as numbers and percentages and compared with Pearson χ^2 and Fischer's exact tests. Parametric data were expressed as mean and standard deviation with the Student *t*-test for comparison. Nonparametric data were depicted as medians and interquartile ranges and compared with the Wilcoxon rank sum test. The overall QOL of APR versus LAR patients was compared with an analysis of covariance, adjusting for age at surgery, body mass index (BMI), chemoradiation use, and 30 days postoperative complications.

RESULTS

Pretreatment characteristics

The database query returned 606 patients. Preoperative QOL assessment responses were available for 153 patients, and only these patients were hence included in this study. Sixty eight (44 percent) patients underwent APR and 85 (56 percent) patients underwent LAR. Five of the 85 LAR operations were intersphincteric resections. The median age was 57 y (interquartile range 49-67), and 49 (32 percent) patients were female. The proportion of patients with

American Society of Anesthesiologists (ASA) classification 3 or 4 was significantly higher in the APR group (45 patients, 65 percent) than in the LAR group (36 patients, 43 percent), $p = 0.04$. The median age of patients undergoing APR (63 y, interquartile range 54-74) was also significantly higher than those undergoing LAR (55 y, interquartile range 45-61), $p < 0.001$. Other demographics and preoperative morbidity were not significantly different between the two groups.

As expected, the median tumor distance from anal verge was significantly shorter in APR (3 cm, interquartile range 2-4) than in LAR patients (4 cm, interquartile range 3-5), $p < 0.01$. All patients undergoing LAR also underwent a diverting stoma creation. Only 6 out of 85 LAR patients still had a diverting loop ileostomy at 6 mo after the index procedure, and 3 out of these received adjuvant chemotherapy.

There were 8 patients (19 percent) with a pretreatment stage (c-stage) I, 22 patients (52 percent) with a c-stage II, 7 patients (17 percent) with a c-stage III, and 5 patients (12 percent) with a c-stage IV. C-stage dispersion was not significantly different between the two groups (Table 1).

Radiotherapy and pathologic stage

A total of 114 patients (74 percent) underwent radiation treatment, with 108 patients (95 percent) undergoing radiation before surgery. The proportion of patients receiving preoperative radiation treatment was significantly higher in the LAR group (67 patients, 79 percent) than in the APR group (41 patients, 60 percent), $p = 0.02$. However, the use of postoperative radiation was higher in patients undergoing APR (5 patients, 7 percent) than in those undergoing LAR (1 patient, 1 percent); this was, however, not statistically significant ($p = 0.06$).

A total of 17 patients (13 percent) had pathologic complete response: 2 patients (5 percent) in the APR group and 15 patients (4 percent) in the LAR group, $p = 0.02$. Twelve (8 percent) patients were pathologic stage (p-stage) I, 33 patients (22 percent) p-stage II, 45 patients (29 percent) p-stage III, and 8 patients (5 percent) p-stage IV. Excluding patients with pathologic complete response, the p-stages

Table 1 - Pretreatment characteristics.

Variables	APR 68 (44%)	LAR 85 (56%)	p Value
Age (years)	63 (54-74)	55 (45-61)	<0.001
Gender (Female)	26 (38)	23 (27)	0.14
BMI kg/m ²	28 (24-32)	26 (23-30)	0.11
ASA			
1	1 (1)	1 (1)	0.04
2	23 (34)	48 (56)	
3	42 (62)	35 (41)	
4	2 (3)	1 (2)	
DAV (cm)	3 (2-4)	4 (3-5)	<0.001
Clinical stage			0.17
I	13 (19)	16 (19)	
II	39 (57)	41 (48)	
III	7 (10)	20 (24)	
IV	9 (14)	8 (9)	

Continuous variables expressed as medians and interquartile ranges. Nominal variables expressed as absolute numbers with percentages in parenthesis.

APR: Abdominoperineal resection, LAR: Low anterior resection, BMI: Body mass index, ASA: American Society of Anesthesiologists classification, DAV: Distance from anal verge.

were not significantly different between LAR and APR patients (Table 2).

Postoperative complications

Table 3 outlines the 30 d postoperative complications. Except for urinary retention, which was more common among patients undergoing APR, all other complications rates were not significantly different between the two surgical groups.

Overall QOL

Table 4 demonstrates the SF-36 physical (pSF-36) and mental (mSF-36) components scores.

Physical component

In the unadjusted analysis, patients undergoing APR had a trend to a lower pSF-36 score at baseline and 36 mo after surgery than those undergoing LAR. However, these differences could not be observed when the analysis was adjusted for age at surgery, BMI, pathologic stage, use of radiation therapy, and 30 days postoperative complications.

Mental component

The mean baseline mSF-36 score was significantly lower in patients undergoing APR (43.56 ± 10.05) than in those undergoing LAR (48.54 ± 9.73), *p* = 0.003. However, this difference could not be observed at the 6-, 12-, and 36-mo postoperative follow-up intervals.

Changes in overall QOL

The changes in the pSF-36 were not significantly different between the two groups during the entire follow-up period. Patients undergoing APR positively changed the mean mSF-36 score in every follow-up period, whereas LAR patients actually decreased their mean mSF-36 score during the follow-up period. (Table 5).

DISCUSSION

This study was designed to compare the overall QOL of patients with low rectal cancer undergoing APR vs. LAR. Our results demonstrate that patients undergoing APR have lower mSF-36 and pSF-36 scores at baseline when compared with patients who undergo LAR. However, in the post-operative period, patients undergoing APR tend to have improvement in SF-36 scores, such that at 6 mo after surgery the overall QOL difference between LAR and APR is no longer statistically significant. This difference further

Table 3 - Postoperative complications.

Variables	APR 68 (44%)	LAR 85 (56%)	<i>p</i> Value
Urinary infection	1 (2)	3 (4)	0.63
Urinary retention	8 (12)	2 (2)	0.02
Wound infection	2 (3)	3 (4)	1
Wound dehiscence	2 (3)	1 (1)	0.59
Abd/Pelvic Abscess	4 (6)	5 (6)	1
Perineal infection	9 (13)	N/A	N/A
Anastomotic leak	N/A	7 (8)	N/A
Reoperation	2 (3)	5 (6)	0.46
Readmission	9 (13)	4 (5)	0.07

Nominal variables expressed as absolute numbers with percentage in parenthesis.
APR: Abdominoperineal resection, LAR: Low anterior resection, Abd: Abdominal, N/A: Not applicable.

decreases and essentially disappears at the 36-mo post-operative period.

The QOL differences between patients undergoing APR and LAR have been studied in the past;¹⁸ however, many of these studies did not use validated tools to assess QOL,¹⁹⁻²¹ included patients without a baseline QOL assessment,²²⁻²⁴ did not adjust the analysis for confounding factors such as age, gender, and tumor staging,^{19,22} or also included patients with upper-third rectal cancers.^{22,25} A 2005 Cochrane review²⁶ regarding the QOL of rectal cancer patients undergoing LAR and APR evaluated a sample of 1,412 from 25 studies. The authors concluded that the studies reviewed did not confirm any conclusions about the QOL of patients undergoing APR being inferior or superior to that of patients who underwent LAR and opined that better designed studies with larger samples are required. The main drawbacks cited by the review were the absence of baseline QOL assessment, inclusion of mid- and upper-third rectal cancers, short follow-up and missing data, and finally no data regarding patient social class.

In an attempt to overcome these limitations of the previous studies, we included only low rectal cancer patients who had the overall QOL assessed prior to surgery. Moreover, we evaluated the overall QOL using the SF-36, a tested and validated measure of health status that was developed in the United States and that is currently validated for use in 13 countries.^{27,28} Finally, we also adjusted the overall QOL to decrease the effect of potentially confounding factors, thus effectively placing more emphasis on the treatment paradigm, that is, APR or LAR.

The fact that patients who underwent APR have a similar long-term QOL to those who underwent LAR is an apparent contradiction to traditional beliefs.¹⁴ An APR is without a doubt a much greater mutilation than an LAR and also has a potentially major impact on body image.²⁹ However, LAR has been associated with side effects that can drastically decrease overall postoperative QOL, including fecal incontinence, urgency and outlet dysfunction, as well as those complications typical of any anastomosis, such as strictures, and leaks.³⁰⁻³³

The realization that a permanent ostomy is inevitable in an attempt to defeat their cancer is likely responsible for the lower QOL at baseline for the APR patients, because this

Table 2 - Radiation therapy and pathologic stage.

Variables	APR 68 (44%)	LAR 85 (56%)	<i>p</i> Value
Preoperative radiation	41 (60)	67 (79)	0.02
Postoperative radiation	5 (7)	1 (1)	0.06
Pathologic complete response	2 (3)	15 (18)	0.02
Pathologic stage			0.5
I	20 (29)	30 (35)	
II	18 (26)	15 (18)	
III	24 (35)	21 (24)	
IV	4 (6)	4 (5)	

Nominal variables expressed as absolute numbers with percentage in parenthesis.
APR: Abdominoperineal resection, LAR: Low anterior resection.

Table 4 - Overall quality of life.

SF-36 component	APR 68 (44%)	LAR 85 (56%)	Nonadjusted analysis		Adjusted analysis ^b	
			Difference in means ^a (95% CI)	p Value	Difference in means ^a (95% CI)	p Value
Physical						
Baseline	44.8 ± 9.2 N = 68	47.7 ± 8.8 N = 85	+2.9 (+0.03 to +5.85)	0.05	+1.7 (-1.6 to +5.0)	0.32
6 mo	43.6 ± 10.0 N = 25	46.14 ± 8.3 N = 48	+2.5 (-1.8 to +6.8)	0.26	+1.6 (-2.8 to +6.1)	0.48
12 mo	46.3 ± 10.6 N = 30	48.3 ± 7.7 N = 55	+2.0 (-1.9 to +5.9)	0.33	+1.3 (-3.1 to +5.6)	0.56
36 mo	45.2 ± 11.3 N = 25	50.5 ± 9.2 N = 29	+5.3 (-0.2 to +10.8)	0.06	+6.6 (-1.0 to +12.2)	0.22
Mental						
Baseline	43.6 ± 10.1 N = 68	48.5 ± 9.7 N = 85	+5.0 (+1.8 to +8.2)	0.003	+5.6 (+1.9 to +9.3)	0.003
6 mo	46.4 ± 10.4 N = 25	46.3 ± 9.0 N = 48	-0.1 (-4.6 to +4.5)	0.98	-0.3 (-5.3 to +4.8)	0.92
12 mo	48.0 ± 9.8 N = 30	47.6 ± 9.0 N = 55	-0.5 (-4.6 to +3.7)	0.83	+0.14 (-4.5 to +4.8)	0.95
36 mo	47.4 ± 10.0 N = 25	49.9 ± 8.1 N = 29	+2.5 (-2.4 to +7.3)	0.32	+2.8 (-2.4 to +7.9)	0.29

Values expressed as means and standard deviation. SF-36: Short form. A complete quality of life follow-up could not be obtained for a portion of patients involved in this study.

APR: Abdominoperineal resection, LAR: Low anterior resection, CI: Confidence interval. ^a Calculated by subtracting the mean SF-36 score of APR from LAR at the time of the assessment. ^b Analysis adjusted for age at surgery, body mass index, pathologic stage, use of radiation therapy, and 30 d postoperative complications.

was obtained in the preoperative period. A further corroboration of this premise is the finding that the mSF-36 score was lower for APR rather than LAR patients, although the pSF-36 score was similar between groups. In contrast, the hope that LAR carries, of avoiding a permanent stoma, may lead to patients being more hopeful and positive prior to surgery, as depicted by the higher baseline mSF-36 score. Thus LAR patients may carry a higher expectation for surgical outcomes than APR patients. However, LAR may be associated with multiple side effects as discussed, which may affect QOL after surgery, regardless of how well patients have been counseled about these factors by their surgeons. As a result, when LAR patients are in the midst of

having to adapt to their new lifestyle governed by bowel function, the potential for frustration can be great, because it may contradict these expectations. On the other hand, patients undergoing APR typically have a lower preoperative expectation, and, following the realization that they can lead a fairly normal life despite coping with a stoma, they may become more satisfied on average, postoperatively. This is further supported by the fact that, in our study, the major changes in overall QOL happened in the mSF-36, with LAR patients decreasing their mSF-36 scores throughout the follow-up period, whereas that of APR patients increased.

The confidence intervals for mean differences between the groups presented in Tables 4 and 5 have lower and upper

Table 5 - Changes in overall quality of life.

SF-36 component	APR 68 (44%)	LAR 85 (56%)	Nonadjusted analysis		Adjusted analysis ^b	
			Difference in means ^a (95% CI)	p - Value	Difference in means ^a (95% CI)	p Value
Physical						
6 mo	-1.7 ± 11.6 N = 25	-2.0 ± 9.5 N = 48	-0.4 (-5.4 to +4.6)	0.88	+0.4 (-5.1 to +5.9)	0.89
12 mo	1.0 ± 8.7 N = 30	-1.12 ± 9.7 N = 55	-2.2 (-6.4 to +2.1)	0.32	-1.3 (-5.9 to +3.3)	0.58
36 mo	-2.2 ± 11.9 N = 25	-0.6 ± 9.5 N = 29	+1.7 (-4.1 to +7.4)	0.57	+3.2 (-3.1 to +9.4)	0.33
Mental						
6 mo	0.6 ± 10.0 N = 25	-2.5 ± 11.4 N = 48	-3.1 (-8.4 to +2.2)	0.26	-3.1 (-9.1 to +2.9)	0.31
12 mo	4.4 ± 11.0 N = 30	-2.5 ± 10.3 N = 55	-6.9 (-11.7 to +2.2)	0.005	-7.9 (-13.1 to +2.6)	0.004
36 mo	2.5 ± 11.2 N = 25	-1.5 ± 11.1 N = 29	-4.0 (-10.0 to +2.0)	0.2	-4.2 (-10.7 to +2.3)	0.21

Values expressed as means and standard deviation. SF-36: Short form, APR: Abdominoperineal resection, LAR: Low anterior resection, CI: Confidence interval.

A complete quality of life (QOL) follow-up could not be obtained for a portion of patients involved in this study. Changes in QOL calculated by subtracting the mean SF-36 score from the baseline mean SF-36 score. ^a Calculated by subtracting the changes in SF-36 score of LAR from change in SF-36 score of APR patients. ^b Analysis adjusted for age at surgery, pathologic stage, use of radiation therapy, and 30 d postoperative complications.

limits with absolute values that typically do not exceed 10 points, and at most are as high as 13.1 points. McHorney and Tarlov³⁴ estimated that a 13-point change in an SF-36 score would be necessary to generate a clinically significant change. Using a 13-point criterion, one would conclude, based on our confidence interval results, that the SF-36 outcomes in the APR and LAR groups are practically equivalent.

Our study suffers from the limitations of a retrospective review. In order to more accurately assess changes in QOL after surgery, only those patients who had completed the preoperative QOL questionnaire were included. Therefore, one could argue that our study cohort may not be representative of the experience of all patients who underwent surgery within our department during the study period. In order to minimize this potential limitation, we compared the demographics, tumor and treatment characteristics, and oncologic outcomes of the patients included in the study with those who were excluded. No statistically significant difference could be found between the two groups, suggesting that the study group likely had characteristics similar to the entire population.

In the face of several statistically nonsignificant results as they relate to QOL comparison, one could argue whether our study has sufficient evidence to suggest that the outcomes for the APR and LAR groups are similar. The confidence intervals for mean differences between the groups presented in Tables 4 and 5 have absolute values that, with few exceptions, do not exceed 10 points and have an upper limit of 13.1 points. McHorney and Tarlov³⁴ estimated that a 13-point change in an SF-36 score would be necessary to generate a clinically significant change. Therefore, using a 13-point criterion, one would conclude that, based upon our confidence interval results, the SF-36 outcomes in the APR and LAR groups are essentially equivalent.

Although all patients had a baseline QOL assessment, this assessment did not take place for every patient at all of the follow-up periods. As a result, different samples were formed in each period. Also, we could not evaluate other factors affecting QOL, such as urinary and sexual function. Moreover, excluding patients without baseline QOL assessment might have created a unique sample that could not retract the reality. Because QOL is likely associated with multiple other factors³⁵ these results may be confounded by such factors. In order to circumvent this possibility, we adjusted our analysis for the following factors that might influence QOL: age at surgery,³⁶ BMI,³⁷ pathologic stage,²⁶ use of radiation therapy,³⁸ and 30 d postoperative complications.³⁹

The results of this study that evaluated preoperative and follow-up SF-36 over a prolonged postoperative period for a large cohort of patients are likely a reflection of general QOL of patients undergoing the two operations. Irrespective of the reasons for the results, the finding that patients undergoing APR for low rectal cancer have long-term QOL similar to those undergoing restorative resection is likely to have implications for practice. The decision as to the correct surgical approach, that is, LAR or APR, is sometimes extremely difficult for some patients with rectal cancer close to but not involving the sphincter. In these circumstances, there may understandably be a significant amount of emotional pressure on both the patient and the clinician to favor a restorative resection over a permanent

stoma. The findings of this study, which showed that patients with low rectal cancer after APR have an equivalent general QOL to LAR patients over the long term, may help preoperatively counsel patients for whom the decision to perform APR has been made. Further, the findings may also foster more rational treatment decisions that are guided predominantly by expectations of oncologic outcomes both pre-and intraoperatively by clinicians, when they are faced with ambivalence as to the preferential approach for patients with ultra-low-lying rectal cancer.

CONCLUSION

Patients undergoing APR for low rectal cancer have similar long-term overall QOL as those undergoing restorative resection. These findings will help counsel patients with low rectal cancers, who are being considered for APR.

REFERENCES

- Jemal A, Siegel R, Ward E, Hao Y, Xu J, Thun MJ. Cancer statistics, 2009. *CA Cancer J Clin.* 2009;59:225-49, doi: 10.3322/caac.20006.
- Heald RJ, Ryall RD. Recurrence and survival after total mesorectal excision for rectal cancer. *Lancet.* 1986;1:1479-82, doi: 10.1016/S0140-6736(86)91510-2.
- Carlsen E, Schlichting E, Guldvog I, Johnson E, Heald RJ. Effect of the introduction of total mesorectal excision for the treatment of rectal cancer. *Br J Surg.* 1998;85:526-9.
- Wibe A, Moller B, Norstein J, Carlsen E, Wiig JN, Heald RJ, et al. A national strategic change in treatment policy for rectal cancer--implementation of total mesorectal excision as routine treatment in Norway. A national audit. *Dis Colon Rectum.* 2002;45:857-66, doi: 10.1007/s10350-004-6317-7.
- Sauer R, Becker H, Hohenberger W, Rodel C, Wittekind C, Fietkau R, et al. Preoperative versus postoperative chemoradiotherapy for rectal cancer. *N Engl J Med.* 2004;351:1731-40.
- Janjan NA, Abbuzzese J, Pazdur R, Khoo VS, Cleary K, Dubrow R, et al. Prognostic implications of response to preoperative infusional chemoradiation in locally advanced rectal cancer. *Radiother Oncol.* 1999;51:153-60, doi: 10.1016/S0167-8140(99)00054-7.
- Gravalos C, Garcia-Escobar J, Garcia-Alfonso P, Cassinello J, Malon D, Carrato A. Adjuvant chemotherapy for stages II, III and IV of colon cancer. *Clin Transl Oncol.* 2009;11:526-33, doi: 10.1007/s12094-009-0397-8.
- Giantonio BJ, Catalano PJ, Meropol NJ, O'Dwyer PJ, Mitchell EP, Alberts SR, et al. Bevacizumab in combination with oxaliplatin, fluorouracil, and leucovorin (FOLFOX4) for previously treated metastatic colorectal cancer: results from the Eastern Cooperative Oncology Group Study E3200. *J Clin Oncol.* 2007;25:1539-44, doi: 10.1200/JCO.2006.09.6305.
- O'Neil BH, Tepper JE. Current options for the management of rectal cancer. *Curr Treat Options Oncol.* 2007;8:331-8, doi: 10.1007/s11864-007-0048-7.
- Perry WB, Connaughton JC. Abdominoperineal resection: how is it done and what are the results? *Clin Colon Rectal Surg.* 2007;20:213-20, doi: 10.1055/s-2007-984865.
- Wu JS, Fazio VW. Management of rectal cancer. *J Gastrointest Surg.* 2004;8:139-49, doi: 10.1016/j.gassur.2003.10.011.
- Chessin DB, Guillem JG. Abdominoperineal resection for rectal cancer: historic perspective and current issues. *Surg Oncol Clin N Am.* 2005;14:569-86, vii., doi: 10.1016/j.soc.2005.04.002.
- Wibe A, Syse A, Andersen E, Tretli S, Myrvold HE, Soreide O, et al. Oncological outcomes after total mesorectal excision for cure for cancer of the lower rectum: anterior vs. abdominoperineal resection. *Dis Colon Rectum.* 2004;47:48-58, doi: 10.1007/s10350-003-0012-y.
- Yau T, Watkins D, Cunningham D, Barbachano Y, Chau I, Chong G. Longitudinal assessment of quality of life in rectal cancer patients with or without stomas following primary resection. *Dis Colon Rectum.* 2009;52:669-77, doi: 10.1007/DCR.0b013e31819eb970.
- Tsunoda A, Tsunoda Y, Narita K, Watanabe M, Nakao K, Kusano M. Quality of life after low anterior resection and temporary loop ileostomy. *Dis Colon Rectum.* 2008;51:218-22, doi: 10.1007/s10350-007-9101-7.
- O'Leary DP, Fide CJ, Foy C, Lucarotti ME. Quality of life after low anterior resection with total mesorectal excision and temporary loop ileostomy for rectal carcinoma. *Br J Surg.* 2001;88:1216-20.
- RAND Corporation. Medical Outcomes Study: 36-Item Short Form Instrument Survey. 2010; Available at: http://www.rand.org/health/surveys_tools/mos/mos_core_36item.html. Accessed 2/26/2011, 2011.
- Cornish JA, Tilney HS, Heriot AG, Lavery IC, Fazio VW, Tekkis PP. A meta-analysis of quality of life for abdominoperineal excision of rectum

- versus anterior resection for rectal cancer. *Ann Surg Oncol*. 2007;14:2056-68, doi: 10.1245/s10434-007-9402-z.
19. Frigell A, Ottander M, Stenbeck H, Pahlman L. Quality of life of patients treated with abdominoperineal resection or anterior resection for rectal carcinoma. *Ann Chir Gynaecol*. 1990;79:26-30.
 20. Kuchenhoff J, Wirsching M, Druner HU, Herrmann G, Kohler C. Coping with a stoma - a comparative study of patients with rectal carcinoma of inflammatory bowel diseases. *Psychother Psychosom*. 1981;36:98-104, doi: 10.1159/000287532.
 21. Schaube J, Scharf P, Herz R. Quality of life of tumor patients with colostomy. *Z Gastroenterol*. 1996;34:Suppl 2:55-6.
 22. Wilson TR, Alexander DJ, Kind P. Measurement of health-related quality of life in the early follow-up of colon and rectal cancer. *Dis Colon Rectum*. 2006;49:1692-702, doi: 10.1007/s10350-006-0709-9.
 23. Camilleri-Brennan J, Steele RJ. Objective assessment of morbidity and quality of life after surgery for low rectal cancer. *Colorectal Dis*. 2002;4:61-6, doi: 10.1046/j.1463-1318.2002.00300.x.
 24. Arndt V, Merx H, Stegmaier C, Ziegler H, Brenner H. Restrictions in quality of life in colorectal cancer patients over three years after diagnosis: a population based study. *Eur J Cancer*. 2006;42:1848-57.
 25. Camilleri-Brennan J, Steele RJ. Prospective analysis of quality of life and survival following mesorectal excision for rectal cancer. *Br J Surg*. 2001;88:1617-22.
 26. Pachler J, Wille-Jorgensen P. Quality of life after rectal resection for cancer, with or without permanent colostomy. *Cochrane Database Syst Rev*. 2005;18:CD004323.
 27. Bowling A, Bond M, Jenkinson C, Lamping DL. Short Form 36 (SF-36) Health Survey questionnaire: which normative data should be used? Comparisons between the norms provided by the Omnibus Survey in Britain, the Health Survey for England and the Oxford Healthy Life Survey. *J Public Health Med*. 1999;21:255-70, doi: 10.1093/pubmed/21.3.255.
 28. Gandek B, Ware JE, Jr, Aaronson NK, Alonso J, Apolone G, Bjorner J, et al. Tests of data quality, scaling assumptions, and reliability of the SF-36 in eleven countries: results from the IQOLA Project. International Quality of Life Assessment. *J Clin Epidemiol*. 1998;51:1149-58, doi: 10.1016/S0895-4356(98)00106-1.
 29. Gervaz P, Bucher P, Konrad B, Morel P, Beyeler S, Lataillade L, et al. A Prospective longitudinal evaluation of quality of life after abdominoperineal resection. *J Surg Oncol*. 2008;97:14-9, doi: 10.1002/jso.20910.
 30. de Miguel M, Oteiza F, Ciga MA, Armendariz P, Marzo J, Ortiz H. Sacral nerve stimulation for the treatment of faecal incontinence following low anterior resection for rectal cancer. *Colorectal Dis*. 2011;13:72-7, doi: 10.1111/j.1463-1318.2009.02066.x.
 31. Pala C, Serventi F, Paliogiannis P, Trignano E, Attene F, Scognamillo F, et al. Functional sequelae after low anterior rectal surgery. *Ann Ital Chir*. 2009;80:193-7.
 32. Rahbari NN, Weitz J, Hohenberger W, Heald RJ, Moran B, Ulrich A, et al. Definition and grading of anastomotic leakage following anterior resection of the rectum: a proposal by the International Study Group of Rectal Cancer. *Surgery*. 2010;147:339-51, doi: 10.1016/j.surg.2009.10.012.
 33. Ho YH, Ashour MA. Techniques for colorectal anastomosis. *World J Gastroenterol*. 2010;16:1610-21.
 34. McHorney CA, Tarlov AR. Individual-patient monitoring in clinical practice: are available health status surveys adequate? *Qual Life Res*. 1995;4:293-307, doi: 10.1007/BF01593882.
 35. The WHOQOL Group. The World Health Organization Quality of Life Assessment (WHOQOL): position paper from the World Health Organization. *Soc Sci Med*. 1995;41:1403-09, doi: 10.1016/0277-9536(95)00112-K.
 36. Violi V, Detullio P, Zinicola R, Costi R, Oneda P, Iusco D, et al. Quality of life assessment in geriatric surgery. *Acta Biomed*. 2005;76 Suppl 1:59-63.
 37. Wiczinski E, Doring A, John J, von Lengerke T, KORA Study Group. Obesity and health-related quality of life: does social support moderate existing associations? *Br J Health Psychol*. 2009;14:717-34.
 38. Allal AS, Gervaz P, Gertsch P, Bernier J, Roth AD, Morel P, et al. Assessment of quality of life in patients with rectal cancer treated by preoperative radiotherapy: a longitudinal prospective study. *Int J Radiat Oncol Biol Phys*. 2005;61:1129-35, doi: 10.1016/j.ijrobp.2004.07.726.
 39. Yost KJ, Hahn EA, Zaslavsky AM, Ayanian JZ, West DW. Predictors of health-related quality of life in patients with colorectal cancer. *Health Qual Life Outcomes*. 2008;6:66, doi: 10.1186/1477-7525-6-66.