The American Journal of Surgery 218 (2019) 119–124

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Predictors of one-year outcomes following the abdominoperineal resection

Ahmet Rencuzogullari, Maher A. Abbas, Scott Steele, Luca Stocchi, Tracy Hull, Sinan Binboga, Emre Gorgun*

Department of Colorectal Surgery, Digestive Disease Institute, Cleveland Clinic, Cleveland, OH, USA

ARTICLE INFO

Article history:
Received 7 June 2018
Received in revised form
12 August 2018
Accepted 26 August 2018

Keywords:
Abdominoperineal resection
Readmission
Reoperation
Perineal wound complications

ABSTRACT

Purpose: This study aimed to determine one-year outcomes and the impact of various factors on the need for readmission and reoperation following abdominoperineal resection (APR).

Method: A multivariate logistic regression analysis was conducted to determine predictors of readmission and/or reoperation within one year of APR performed between January-2000 and December-2013.

Results: 536 patients were analyzed for whom the most common indication for surgery was rectal cancer(86.4%). Within one year of operation, 14.2% (n = 76) of patients have major (grade III/IV of Clavien-Dindo [CD]) and 26.1%(n = 140) of patients have minor complications (grade I/II of CD). Respective major and minor perineal wound complication(PWC) rates were 10.4% and 5.6%.Readmission and reoperation rates within 90 days following discharge were 25% and 8.8%, respectively. While PWC (n = 53,39.2%) and small bowel obstruction(n = 23,17%) were the most common causes of readmission within 90 days,PWC(n = 20,23.3%) and distant metastasis(n = 20,23.3%) were the main causes of long-term readmission(90-day to 1 year).

Conclusion: Perineal wound complications were the most common cause of readmission and reoperation within one year of APR. Well-coordinated efforts aimed at decreasing the perineal wound morbidity may impact the need for readmission and reoperation.

Published by Elsevier Inc.

Introduction

In the last decade, there has been evolving interest in improving the post-operative care of patients undergoing colorectal surgery. In the era of bundled payment and ongoing cuts in healthcare reimbursement, more work to reduce cost, readmission, morbidity and mortality is needed after colorectal surgery.[1] Despite an increasing trend towards sphincter-saving surgery and/or multimodality treatment for low rectal and anal cancer, some patients still require abdominoperineal resection (APR) for curative intent or palliation.[2–4] Unfortunately, APR is still associated with significant morbidity, including significant wound complications (*i.e.*, hemorrhage, infection, wound dehiscence), reoperation, mortality, and readmission.

Ongoing initiatives to improve post-operative care and to examine underlying reasons of readmission and reoperation for patients undergoing APR are needed. Yet, most of the APR-related outcomes studies have focused mainly on the oncological results, with few evaluating both oncologic and post-operative outcomes.[3–9] To date there is a paucity of publications on non-oncologic short- and long-term APR-related outcomes. Further, most studies only evaluate short-term outcomes, and primarily during the index hospitalization.[2,5,8] We aimed to evaluate the impact of various factors on short-term and long-term readmission and need for reoperation following APR. We hypothesized that most of underlying reasons of post-APR readmission and reoperation are potentially preventable and are not limited within commonly reported 30-day of index operation.

Patients and methods

A retrospective review was performed of all patients who underwent elective APR at the Cleveland Clinic, Ohio, between 2000 and 2013. Data were obtained from an IRB-approved prospectively

* Corresponding author. Department of Colorectal Surgery, Cleveland Clinic, 9500 Euclid Ave. A-30, Cleveland, OH 44195, USA.
E-mail address: gorgune@ccf.org (E. Gorgun).

https://doi.org/10.1016/j.amjsurg.2018.08.021
0002-9610/Published by Elsevier Inc.

maintained institutional database, which included inpatient and outpatient electronic healthcare records. Missing data were supplied by chart review. Indications for APR included both malignant and benign disorders. Our primary outcome measure was APR-related readmission and reoperation within one year of the index operation. Outcome measures were classified as short-term (within 90 days of APR) and long-term (90 days–1 year). Excluded from analysis were patients who underwent APR under emergency circumstances, patients who underwent extralevator APR (n = 3), and patients whose perineal wound was left open at index operation.

Patient related factors included: age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) score, the age-adjusted Charlson Comorbidity Index (CCI) score,[10] wound classification, history of prior abdominal surgery, prior chemotherapy and/or radiotherapy, smoking, alcohol history, and baseline hemoglobin (g/dL) and albumin (mg/dL) levels.

Intraoperative factors included operation type (open, laparoscopic, or robotic), wound closure type (primary vs. flap use), omental pedicle flap use, operative time, estimated blood loss, need for transfusion, and intraoperative complications. Postoperative outcome measures included admission to intensive care unit, total hospital stay, overall complications, need for postoperative transfusion, readmission, need for reoperation, and mortality rates. Indications for readmission and reoperation were identified via query of electronic records, corroborated by patients' charts as necessary. Mechanical bowel preparation is used for all patients in a standardized fashion. Patients received polyethylene glycol (PEG) and were instructed to take clear liquids on the day of preparation, to begin the PEG lavage solution at 3:00 p.m., and to complete it at 7:00 p.m.

Post-APR complications are classified based on Clavien-Dindo. Major perineal wound complications included dehiscence requiring any intervention (negative wound therapy or reoperation), infection/abscess requiring drainage/debridement and perineal bleeding requiring reoperation. Minor perineal wound complications included stitch abscess, sinus tracts and wound separation (<2 cm) managed conservatively. Readmission was defined as any unplanned hospitalization related to the APR operation. Wound infection was defined as an erythematous, tender swelling of the wound or surrounding tissue with purulent drainage from the perineal wound, or clinical signs of infection requiring wound opening or antibiotic treatment. Complete separation of a surgically closed wound after principal operative procedure was defined as dehiscence.

Statistical analysis

Bivariate associations with individual outcomes were assessed using logistic regression analyses, yielding estimates of odds ratios and their 95% confidence intervals. Multivariate logistic models were constructed for outcomes using stepwise variable selection in which the inclusion and exclusion of individual predictors was considered at each step and decided upon using Akaike's information criterion (AIC) to measure the relative potential improvement in models.

In particular, due to the potential clinical relevance, stepwise logistic regression models for both 90 day and 90-day to 1-year readmission, reoperation, and mortality-related outcomes were constructed using the following variables: preoperative: age, gender, BMI, ASA score, surgical approach, (open or laparoscopic), indication for surgery, CCI score, prior abdominal surgery, preoperative chemotherapy and radiotherapy, smoking, alcohol use, anemia (hgb<14 male, hgb<12 (g/dL) female), albumin level (g/dL); -intraoperative: wound class, closure technique (primary vs flap use), omental pedicle flap creation, operating time, and estimated blood loss and blood transfusion (intraoperative or postoperative). For each outcome measure, candidate predictors for the stepwise selection procedure were selected based on bivariate results significant at the 0.10 level or based on potential clinical relevance to the outcome.

Results

During the study period 536 patients underwent APR and met the inclusion criteria. The mean age was 61.6 ± 13.9 years and 305 patients (56.9%) were men. Table 1 represents baseline patient's characteristics and intraoperative findings of total cohort and comparison between patients who required readmission compared to those who did not. The most common indication for surgery was rectal cancer (86.4%), followed by anal cancer (7.1%), and inflammatory bowel disease (4.3%). The mean CCI was significantly higher for patients who readmitted (3.2 ± 1.2 vs 2.9 ± 1.1, p = 0.002). Sixty-five patients (12.1%) underwent a minimally invasive approach. Perineal defects were primarily closed in 520 patients (97.0%), whereas flap closure was conducted in 16 patients (3.0%). Omental pedicle flap was performed in 426 patients (79.5%) during the index procedure.

Within one year of operation, 14.2% (n = 76) of patients have major complications (grade III/IV of Clavien-Dindo classification) and 26.1% (n = 140) of patients experienced minor complications (grade I/II of Clavien-Dindo classification). Post-operative outcomes are listed in Table 2. Respective 90-day and 90-day to 1-year readmission rates were 24.8% and 17.7%. The timing of short-term readmission is presented in Fig. 1. The highest proportion of readmission episodes occurred within the first 30 days following surgery (72.1%). While PWC (n = 53, 39.2%) and small bowel obstruction (SBO) (n = 23, 17%) were the most common causes for 90-day readmission, PWC (n = 20, 23.3%) and distant metastasis (n = 20, 23.3%) were the most frequent causes for 90-day to one-year readmissions.

Based on univariate results, patients undergoing APR for anal cancer experienced higher, but not statistically significant, rate of major perineal wound complications compared to other indications (21.1% vs 9.9%: rectal cancer, 4.3%: inflammatory bowel disease; p = 0.15). Major and minor perineal wound complication (PWC) rates were 10.4% (n = 56) and 5.6% (n = 30), respectively. Neither neoadjuvant chemo (11.6% vs %, 8.6%, p = 0.28) nor radiotherapy (11.7% vs 9%, p = 0.37) differed significantly between the patients with and without PWC. No association between omentoplasty and major PWC were noted (p = 0.86). Although a pelvic drain was replaced in the majority of patients (n = 500, 93.3%), there was no significant benefit observed in terms of reduced perineal wound breakdown (p = 078). Major PWCs were managed with reoperation (n = 28, 3 of those with flap procedure), negative wound therapy (n = 17), and drainage (percutaneous: n = 6; open: n = 5). For those patients with major PWCs, further unplanned readmission rate up one-year of index operation remained high with a rate of 29% (n = 16); of which six patients readmitted different complications other from the wound site (urinary complications; n = 2, stomal stenosis; n = 1, plevral effusion; n = 1; incisional hernia; n = 1 and liver metastasis; n = 1). Within one-year of APR, four patients with SBO (n = 30, 5.6%) and half of patients who experienced stoma-related complications necessitating unplanned readmission (n = 14, 2.6%) were managed with reoperation. Table 3 summarizes the reasons for short- and long-term readmission. The 90-day reoperation rate was 8.8%. PWCs (n = 21 dehiscence, n = 11 bleeding, n = 6 pelvic abscess) were the most common reasons for 90-day reoperation.

As the most common cause of major perineal wound complications, the following independent risk factors were found with

Table 1
Baseline patient's characteristics and intraoperative findings with comparison of patients who were readmitted within 90 days and those did not.

Variable	N = 536 (SD, %)	No 90-day Readmission (N = 402)	90-day Readmission (N = 133)	P-value
Age, years	61.6 ± 13.90	62.0 ± 13.7	60.1 ± 14.2	0.13
Male gender	305 (56.9%)	240 (60.0%)	62 (46.6%)	0.007
BMI, Kg/m^2	28.2 ± 6.5	27.9 ± 5.8	29.1 ± 8.1	0.49
ASA score				0.08
I-II	186 (34.7%)	148 (37.0%)	38 (28.6%)	
III-IV	350 (65.3%)	252 (63.0%)	95 (71.4%)	
Charlson Comorbidity Score	2.9 ± 1.13	2.9 ± 1.1	3.2 ± 1.2	0.002
Smokers (n = 528)	119 (22.5%)	88 (22.4%)	30 (22.7%)	0.94
Alcohol use[#]	210 (39.8%)	168 (42.7%)	42 (31.8%)	0.027
Preoperative Chemotherapy	333 (66.7%)	246 (66.5%)	86 (68.3%)	0.72
Preoperative Radiotherapy	343 (68.7%)	252 (68.1%)	90 (71.4%)	0.49
Indications				0.024
Rectal cancer	463 (86.4%)	349 (87.2%)	111 (83.5%)	
Anal cancer	38 (7.1%)	23 (5.8%)	15 (11.3%)	
IBD	23 (4.3%)	16 (4.0%)	7 (5.3%)	
Others[a]	12 (2.2%)	12 (3.0%)	0 (0%)	
Anemia[c]	39.2 ± 4.5	39.3 ± 4.4	38.3 ± 5.1	0.26
Albumin level, (g/dL)	3.9 ± 0.6	3.9 ± 0.5	3.9 ± 0.6	0.93
Prior Abdominal Surgery	252 (47.0%)	173 (43.2%)	77 (57.9%)	0.004
Minimally-invasive surgery[b]	65 (12.1%)	50 (12.5%)	15 (11.3%)	0.71
Wound Classification (n = 388)				0.75
Clean-contaminated	336 (86.6%)	250 (86.2%)	84 (87.5%)	
Contaminated or dirty	52 (13.4%)	40 (13.8%)	12 (12.5%)	
Blood transfusion (intraoperative)	72 (13.4%)	49 (12.2%)	23 (17.3%)	0.14
Blood transfusion (postoperative)	100 (18.7%)	67 (16.8%)	32 (24.1%)	0.06
Mean transfused blood, unit	0.38 ± 1.0	0.30 ± 0.8	0.60 ± 1.5	0.04
ICU hospitalization	52 (9.7%)	37 (9.2%)	13 (9.8%)	0.86
Closure technique				0.034
Primary	520 (97.0%)	392 (98.0%)	125 (94.0%)	
Flap	16 (3.0%)	8 (2.0%)	8 (6.0%)	
Omentoplasty	110 (20.5%)	88 (22.0%)	21 (15.8%)	0.13
Estimated blood loss, millimeters	560 ± 558	531 ± 518	642 ± 656	0.2
Operating time, minutes	232 ± 104	221 ± 96	258 ± 117	0.011

Values are expressed as absolute numbers (percentages). SD: Standard Deviation, BMI: Body Mass Index, ASA: American Society of Anesthesiologists, IBD: Inflammatory Bowel Disease ICU: Intensive Care Unit.
[a] Fecal incontinence, stricture without marked malignant disease, persistent colovesical/colovaginal fistula, prolapse, radiation proctitis without marked malignant disease.
[b] Minimally-invasive surgery: laparoscopic (n = 55), robotic (n = 11).
[c] Hgb <13.5 g/dL in men, and <12.0 g/dL anemia in women.

respect to the AIC criterion by remaining in the final stepwise logistic regression model: intraoperative blood transfusion [p = 0,029, OR = 1.363 (1.05–1.77)], flap vs primary closure [p = 0,014, OR = 4.515 (1.47–13.83)] and female gender [p = 0,041, OR = 1.906 (1.019–3.563)]. Stepwise logistic regression models for predicting 90-day outcomes (readmission, reoperation and mortality) are presented in Table 4. Prior abdominal surgery (p = 0.012), female gender (p = 0.017), higher CCI score (p < 0.001), younger age (p = 0.003), and postoperative blood transfusion (p = 0.035) were found to be independently associated with 90-day readmission. Flap creation and omental pedicle flap use remained in the final model of 90-day readmission, but they did not reach at significant statistical level. Table 5 demonstrates stepwise logistic regression models for specific outcomes for 90-days to 1 year. While alcohol consumption was independent risk factor for readmission

Table 2
Overall post-operative outcomes.

Variable	N = 536 (%)
Major perineal wound complications[a]	56 (10.4)
Minor perineal wound complications[b]	30 (5.6)
Postoperative ileus	57 (10.6)
Urinary retention	41 (7.6)
Urinary tract infection	21 (3.9)
Intra-abdominal abscess	18 (3.4)
Stoma-related complications	18 (3.4)
Perineal wound dehiscence	18 (3.4)
Pelvic abscess	17 (3.2)
Deep vein thrombosis	7 (1.3)
Pneumonia	6 (1.1)
Acute renal failure	6 (1.1)
Length of hospitalization, days	9.1 ± 5.7
Surgical site infection	48 (9.0)
ICU hospitalization	52 (9.7)
90-day readmission	133 (25.0)
90-day to one-year readmission	94 (17.7)
90-day reoperation rate	47 (8.8)
90-day mortality	17 (3.2)
90-day to one-year mortality	41 (7.7)

ICU: Intensive Care Unit.
[a] Bleeding and dehiscence requiring any intervention and infection/abscess requiring drainage/debridement.
[b] Wound separation (<2 cm) that managed conservatively, stitch abscess and sinus tracts.

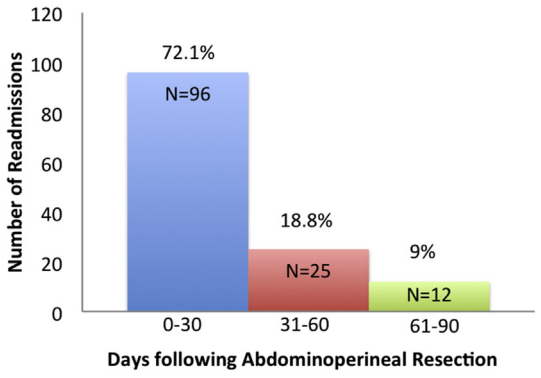

Fig. 1. Distribution of short-term readmissions following abdominoperineal resection.

Table 3
Readmission reasons following abdominoperineal resection.

Within 90-day of surgery	N = 133 (%)
Perineal wound complications[a]	53 (39.8)
Small bowel obstruction	23 (17.2)
Intra-abdominal or pelvic abscess	21 (15.8)
Urinary complications	13 (9.8)
Dehydration/acute renal failure	6 (4.5)
Stoma-related complications	4 (3)
Deep vein thrombosis	3 (2.2)
Others[b]	10 (8.3)
90-day to 1 year following discharge	**N=94 (%)**
Perineal wound complications[c]	20 (23.8)
Distant metastasis[d]	20 (23.8)
Stoma complications[e]	10 (10.6)
Small bowel obstruction	7 (7.4)
Urinary complications	6 (6.4)
Abdominal wall complications	4 (4.3)
Intra-abdominal or pelvic abscess	4(4.3)
Deep vein thrombosis	4(4.3)
Dehydration/acute renal failure	2 (3.2)
Local recurrence	2 (3.2)
Others	17 (18)

[a] Dehiscence (n = 27), infection (n = 24), bleeding (n = 2).
[b] Abdominal pain (n = 2), gastrointestinal bleeding (n = 2), pneumonia (n = 2), decubitus (n = 1), incarcerated inguinal hernia (n = 1), congestive heart failure (n = 1), *C. difficile* colitis (n = 1).
[c] Dehiscence (n = 12), infection (n = 6), perineal hernia (n = 1), chronic fistula (n = 1).
[d] Liver (n = 11), lung metastasis (n = 8), and inguinal (n = 1) metastasis.
[e] Parastomal hernia (n = 6), blockage (n = 4).

(p = 0.033), patients diagnosed with anal cancer had higher likelihood of mortality (p = 0.013) within this time frame.

Discussion

As a leading quality indicator, decreasing hospital readmissions has increasingly become a goal to improve quality of care and reduce expenditures in healthcare. Although readmissions after colorectal surgery have previously been evaluated,[9] data related to readmissions after APR is considerably lacking in the literature.[11,12] Our previous work examining the results of multi-institutional APR patient population has reported the postoperative outcomes with short-term follow-up.[13] The present study is evaluated up to 1-year outcome with a particular emphasize on readmission and reoperation following APR. Since APR is associated with potentially long-term morbidity, instead of the commonly reported 30-day outcomes, 90-day and 1-year outcomes are needed to provide a more accurate assessment of the morbidity of APR. Indeed, we noted that three-quarters of 90-day readmissions occurred within 30-day of index operation.

Increased comorbidity, younger age, female gender, blood transfusion, and prior abdominal surgery were independently associated with readmission for patient who underwent APR. Our rate of 90-day readmission after APR was found to be slightly higher than that of reported rates of 23.3% by Wick[14] and 24% reported by Azimuddin et al.[15] Schneider et al. described the risk factors associated with readmission among a nationwide cohort of patients undergoing colorectal surgery.[1] Some of identified risk factors in their report – increased comorbidity score and blood transfusion – and additional data from another study[16] have also reported the strong association between increased comorbidity and readmission rates which are consistent with our results. Noteworthy finding related to the association between younger age and increased readmission and reoperation can be explained by more aggressive operative, rather than conservative (open dressing or negative pressure wound therapy), treatment in younger population.

Although previous reports analyzing overall perineal complications revealed a great variation in incidence; some factors have been associated with these complications. Preoperative radiation only[17] or combined with chemotherapy,[18] anorectal cancer compared to other indications[8] and comorbidities[5] were linked to increased risk of perineal wound complications. In our series, perineal wound complications were the most common reasons for readmission after one year of APR. Recognizing that perineal

Table 4
Stepwise Logistic Regression Model for 90-day outcomes.

Stepwise Logistic Regression Model for 90-day readmission				
Variable	Value	Parameter Estimate (SE)	Odds Ratio (95% CI)	Likelihood Ratio P-value
Age, per age		0.0255 (0.0087)	0.975 (0.958–0.992)	0.003
Male gender		0.5198 (0.2184)	0.595 (0.388–0.912)	0.017
Closure Technique				0.1
	Primary closure	0	1	
	Flap use	0.9126 (0.5455)	2.491 (0.855–7.256)	
Omentoplasty		0.4376 (0.2802)	1.549 (0.894–2.683)	0.11
Charlson Comorbidity Score, per unit		0.4104 (0.1062)	1.507 (1.224–1.856)	<0.001
Postoperative blood transfusion[b]		0.2026 (0.0995)	1.225 (1.008–1.488)	0.035
Prior Abdominal Surgery		0.5454 (0.2187)	1.725 (1.124–2.649)	0.012
Stepwise Logistic Regression Model for 90-day reoperation rate				
Prior Abdominal Surgery		0.9910 (0.3568)	2.694 (1.339–5.421)	0.004
ASA ≥ 3		1.3152 (0.4372)	3.725 (1.581–8.777)	0.001
Steroid Use		0.8523 (0.5188)	2.345 (0.848–6.483)	0.12
Intraoperative blood transfusion		0.3185 (0.1402)	1.375 (1.045–1.810)	0.024
Age, per age		0.0460 (0.0127)	0.955 (0.932–0.979)	<0.001
Postoperative blood transfusion		0.2170 (0.1217)	1.242 (0.979–1.577)	0.07
Stepwise Logistic Regression Model for 90-day mortality				
Minimally invasive surgery		16.1465 (1275.6)	not estimated[a]	0.045
Age		0.0718 (0.0251)	1.074 (1.023–1.129)	0.002
Intraoperative blood transfusion		0.5460 (0.1796)	1.726 (1.214–2.454)	0.006

[a] Odds ratios were sometimes not estimated when a subgroup of the model variable had too few outcome events.
[b] Transfusion ≥1 unit of whole blood/packed red blood cells within 72 h after surgery.

Table 5
Stepwise Logistic Regression Model for 90-day to 1-year outcomes.

Stepwise Logistic Regression Model for 90-day to 1-year readmission.				
Variable	Value	Parameter Estimate (SE)	Odds Ratio (95% CI)	Likelihood Ratio P-value
Alcohol use		0.5002 (0.2335)	1.649 (1.043–2.606)	0.033
Steroid Use		0.7977 (0.4279)	2.220 (0.960–5.136)	0.07
Preoperative radiation therapy		0.4519 (0.2673)	1.571 (0.930–2.654)	0.08
Stepwise Logistic Regression Model for 90-day to 1-year mortality				
Indication				0.013
	Rectal cancer	0	1	
	Anal cancer	1.3543 (0.4884)	3.874 (1.488–10.090)	
	IBD	−14.9592 (865.9919)	not estimated[a]	
	Others	−14.8960 (1574.3265)	not estimated[a]	
Prior Abdominal Surgery		0.8121 (0.3570)	2.253 (1.119–4.535)	0.021
Male gender		0.8769 (0.3901)	2.403 (1.119–5.163)	0.019
ASA $\geq$ 3		0.5479 (0.4009)	1.730 (0.788–3.795)	0.16

ASA: American Society of Anesthesiologists, IBD: Inflammatory bowel disease.
[a] Odds ratios were sometimes not estimated when a subgroup of the model variable had too few outcome events.

wound complications encompass a wide spectrum of severity, we used strict definitions to classify post-APR wound problems. In this study, blood transfusion was analyzed to determine its impact and is regarded as a cause of major PWCs, readmission and reoperation. The relationship between blood transfusion and impaired short-term outcomes may be explained by the fact that patients requiring increased blood transfusion may have undergone a more complex surgery or complications during the index operation. The detrimental effect of transfusion, believed to be mediated by its complex immunosuppressive features,[19] is another possible explanation for negatively affected short-term outcomes. As shown in our previous work addressing impact of transfusion strategy of restorative rectal surgery outcomes,[20] implementing restrictive transfusion strategy may also lessen post-APR complications.

The perineal wound following APR can be managed in a variety of ways, from primary closure to muscle flap reconstruction. Our data projected that omental pedicle flap use and pelvic drain replacement have no significant impact on perineal wound healing. This link between ometal pedicle flap use and perineal wound healing is supported by previous risk-adjusted comparative study addressing no advantages of omentum in the prevention and management of anastomotic leak and infectious complications in rectal cancer patients,[21] however, the evidence is still inconclusive due to a lack of randomized studies.[22] With regards to the management of major PWC, our results showed that negative pressure wound therapy can be preferred in selected patients to accelerate secondary wound healing. We believe that surgical expertise and availability of a multidisciplinary team approach are important considerations for optimal patient selection.

It is important to note the limitations of this study–it represents a single tertiary center experience. Furthermore, though the majority of patients are from Ohio, some patients were referred from other geographical areas and it is conceivable that not all complications were captured on patients who were followed locally by their referring physician. Despite these drawbacks, the results of this study based on information obtained from a high volume colorectal unit with carefully collected data do provide meaningful and representative information.

In conclusion, prolonged multi-modal postoperative care for APR patients is essential due to complications extending beyond 30 days. Perineal wound complications constitute the main reason for readmission and reoperation within one year after APR. Well-coordinated efforts with an outpatient care team to create an effective perineal wound management strategy will have a positive impact on APR-related quality indicators.

Disclaimer

Conflict of interest and source of funding

The authors have no conflict of interest including relevant financial interests, activities, relationships, and affiliations.

State

Presented at the American Society of Colon and Rectal Surgeons Annual Meeting, May 30th - June 3rd, 2015, Boston, MA.

Author contributions

a. Substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data: Ahmet Rencuzogullari, MD; Sinan Binboga, MD; Maher A. Abbas, MD; Luca Stocchi, MD; Tracy Hull, MD; Emre Gorgun,MD.
b. Drafting the article or revising it critically for important intellectual content: Ahmet Rencuzogullari, MD; Sinan Binboga, MD; Maher A. Abbas, MD; Scott Steele, MD; Luca Stocchi, MD; Tracy Hull, MD; Emre Gorgun,MD.
c. Final approval of the version to be published: Ahmet Rencuzogullari, MD; Maher A. Abbas, MD; Luca Stocchi, MD; Scott Steele, MD; Tracy Hull, MD; Emre Gorgun,MD.

References

1. Schneider EB, Hyder O, Brooke BS, et al. Patient readmission and mortality after colorectal surgery for colon cancer: impact of length of stay relative to other clinical factors. *J Am Coll Surg*. 2012;214(4):390–398.
2. Hawkins AT, Berger DL, Shellito PC, Sylla P, Bordeianou L. Wound dehiscence after abdominoperineal resection for low rectal cancer is associated with decreased survival. *Dis Colon Rectum*. 2014;57(2):143–150.
3. Shihab OC, Brown G, Daniels IR, Heald RJ, Quirke P, Moran BJ. Patients with low rectal cancer treated by abdominoperineal excision have worse tumors and higher involved margin rates compared with patients treated by anterior resection. *Dis Colon Rectum*. 2010;53(1):53–56.
4. Marr R, Birbeck K, Garvican J, et al. The modern abdominoperineal excision: the next challenge after total mesorectal excision. *Ann Surg*. 2005;242(1):74–82.
5. El-Gazzaz G, Kiran RP, Lavery I. Wound complications in rectal cancer patients undergoing primary closure of the perineal wound after abdominoperineal resection. *Dis Colon Rectum*. 2009;52(12):1962–1966.
6. Chuwa EW, Seow-Choen F. Outcomes for abdominoperineal resections are not worse than those of anterior resections. *Dis Colon Rectum*. 2006;49(1):41–49.
7. Régimbeau J, Panis Y, Marteau P, Benoist S, Valleur P. Surgical treatment of anoperineal crohn's disease: can abdominoperineal resection be predicted? *J Am Coll Surg*. 1999;189(2):171–176.
8. Christian CK, Kwaan MR, Betensky RA, Breen EM, Zinner MJ, Bleday R. Risk factors for perineal wound complications following abdominoperineal

resection. *Dis Colon Rectum*. 2005;48(1):43–48.
9. GreenblattDY WeberSM, O'Connor ES, LoConte NK, Liou JI, Smith MA. Readmission after colectomy for cancer predicts one-year mortality. *Ann Surg*. 2010;251:659–669.
10. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chron Dis*. 1987;40(5):373–383.
11. Molina Rodriguez JL, Flor-Lorente B, Frasson M, et al. Low rectal cancer: abdominoperineal resection or low hartmann resection? A postoperative outcome analysis. *Dis Colon Rectum*. 2011;54(8):958–962.
12. Kipling S, Young K, Foster J, et al. Laparoscopic extralevator abdominoperineal excision of the rectum: short-term outcomes of a prospective case series. *Tech Coloproctol*. 2014;18(5):445–451.
13. Rencuzogullari A, Gorgun E, Binboga S, Ozuner G, Kessler H, Abbas MA. Predictors of wound dehiscence and its impact on mortality after abdominoperineal resection: data from the National Surgical Quality Improvement Program. 2016 Jul;20(7):475–482.
14. Wick EC, Shore AD, Hirose K, et al. Readmission rates and cost following colorectal surgery. *Dis Colon Rectum*. 2011;54(12):1475–1479.
15. Azimuddin K, Rosen L, Reed III JF, Stasik JJ, Riether RD, Khubchandani IT. Readmissions after colorectal surgery cannot be predicted. *Dis Colon Rectum*. 2001;44(7):942–946.
16. Kariv Y, Wang W, Senagore AJ, Hammel JP, Fazio VW, Delaney CP. Multivariable analysis of factors associated with hospital readmission after intestinal surgery. *Am J Surg*. 2006;191(3):364–371.
17. Bullard KM, Trudel JL, Baxter NN, Rothenberger DA. Primary perineal wound closure after preoperative radiotherapy and abdominoperineal resection has a high incidence of wound failure. *Dis Colon Rectum*. 2005;48(3):438–443.
18. Artioukh D, Smith R, Gokul K. Risk factors for impaired healing of the perineal wound after abdominoperineal resection of rectum for carcinoma. *Colorectal Dis*. 2007;9(4):362–367.
19. Dionigi G, Rovera F, Boni L, et al. The impact of perioperative blood transfusion on clinical outcomes in colorectal surgery. *Surg Oncol*. 2007;16:177–182.
20. Ozben V, Stocchi L, J1 Ashburn, Liu X, Gorgun E. Impact of a restrictive vs liberal transfusion strategy on anastomotic leakage and infectious complications after restorative surgery for rectal cancer. *Colorectal Dis*. 2017 Aug;19:772–780.
21. Ozben V, Aytac E, Liu X, Ozuner G. Does omental pedicle flap reduce anastomotic leak and septic complications after rectal cancer surgery? *Int J Surg*. 2016 Mar;27:53–57.
22. Nilsson PJ. Omentoplasty in abdominoperineal resection: a review of the literature using a systematic approach. *Dis Colon Rectum*. 2006;49(9):1354–1361.