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Perioperative and oncological outcomes of abdominoperineal resection in the prone position vs the classic lithotomy position: A systematic review with meta-analysis

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Abstract

Background and Objectives: This study is a systematic review with meta-analysis designed to compare the perioperative and oncological outcomes of the abdominoperineal resection (APR) carried out in the prone jack-knife position (P-APR) vs the classic lithotomy position (C-APR).

Methods: We conducted an electronic search through PubMed utilizing the PRISMA guidelines. We included all randomized and nonrandomized studies which allowed for comparative analysis between the two groups. Research that focused on and analyzed the extralevator abdominal excision were excluded. Pooled variables and number of events were analyzed using the random-effect model.

Results: The final analysis included seven nonrandomized retrospective cohorts encompassing 1663 patients. P-APR was associated with decreased operative time (OT) (DM, -43.8 minutes; $P < 0.01$) and estimated blood loss (EBL) (DM, 86.9 mL; $P < 0.01$). There were no observed differences regarding perineal wound infections (PWI) (odds ratio [OR], 0.36; $P = 0.18$), intraoperative perforation of rectum (IOP) (OR, 0.98; $P = 0.97$), circumferential resection margin (CRM) positivity (OR, 1.02; $P = 0.98$) or 5-year LR (OR, 1.00; $P = 0.99$).

Conclusion: The prone approach for APR is associated with decreased EBL and OT, although not with any change in the incidence of PWI or IOP. Moreover, surgical positioning per se does not appear to affect the CRM positivity rates or LR rate.

Keywords

abdominoperineal resection; prognosis; rectal cancer; resection margins; surgery

1 | INTRODUCTION

Colorectal cancer is the most common gastrointestinal malignancy.¹ Rectal cancer (RC) comprises about one-third of the colorectal malignancies and can present as locally advanced disease in 6% to 18% of the cases.² For these patients, neoadjuvant chemoradiation followed by surgical resection with total mesorectal excision (TME) is the standard treatment and provides excellent locoregional control. Depending on the specific anatomic location, both the prognosis and surgical treatment can differ. While proximal tumors are amenable to sphincter-preserving operations, the standard curative operation for locally advanced distal tumors is the abdominoperineal resection (APR). Notwithstanding the more extensive operation, lower rectal tumors still have a higher local recurrence rate when compared with proximal tumors of the same stage.³ In addition to the TME, the APR requires the dissection of a distinct anatomic structure—the pelvic floor with the external sphincter. The absence of a mesorectal envelope at the level of the sphincter can increase the chances of intraoperative tumor perforation and positive circumferential margins.⁴ Furthermore, the creation of a perineal wound defect also leads to an increased number of surgical site infections and dehiscence rates. Aiming to overcome these problems, several authors have advocated changes in the surgical technique³ by adopting the routine use of the prone position and by encompassing the full extent of the sphincter in the resection specimen.⁵

By revisiting the classic Miles operation, the extralevator abdominal excision (ELAPE) technique involves a cylindrical resection of the sphincter and mesorectum, which may decrease rates of intraoperative rectal perforation and improve oncological outcomes.⁶ However, published data from randomized and nonrandomized studies have reported mixed results,^{4,7,8} and a recent meta-analysis failed to identify a difference in the local recurrence rate between the ELAPE and classic APR techniques.⁹ Interestingly, the secondary outcomes reported by these studies show an improvement in operative time (OT), decreased blood loss and fewer perineal wound infections (PWI). Some authors suggest that these benefits are likely secondary to the adoption of the prone position during ELAPE, which yields a better surgical exposure, faster dissection, decreased blood loss, and a more precise perineal wound closure.^{5,10} Indeed, a national survey from the United Kingdom showed that approximately one-third of the surgeons prefer the prone position during APRs.¹¹ Although the rationale to adopt this practice seems appealing, there is no definitive data to support this surgical approach.

Hence, we designed this systematic review of the literature with meta-analysis of the pooled data to compare the short-term surgical outcomes of the APR in prone jack-knife position (P-APR) vs the APR carried out in the classic lithotomy position (C-APR). We also sought to assess whether patient positioning alone can affect circumferential margins and local recurrence rates. To our knowledge, this is the first meta-analysis to date to address this question.

2 | METHODS

Two population, intervention, comparator, and outcome (PICO) questions were generated before the beginning of the literature review: (i) for patients undergoing an APR(P), is there a difference in immediate perioperative outcomes(O) based on whether they were in the prone(I) or lithotomy position(C)?; and (ii) in patients with rectal cancer undergoing an APR(P), is there a difference in recurrence rate or survival(O) between patients in the prone(I) or lithotomy position(C)?

To appropriately address the PICO questions, we conducted a search through PubMed for publications comparing technical and oncological outcomes between APR in prone (P-APR) vs classic lithotomy (C-APR) position. Only English peer-reviewed articles were considered for analysis. PubMed advanced search was used to build the following search terms: (i) “((rectal[Title/Abstract]) AND cancer [Title/Abstract]) AND prone[Title/Abstract]”; (ii) “abdominoperineal [Title/Abstract] AND prone[Title/Abstract]”; (iii) “abdominoperineal [Title/Abstract] AND position[Title/Abstract].” All articles were reviewed by two authors, JWBMN and FIBM, and had their references assessed to identify potentially missed studies during the original search. We also reviewed the PubMed related recommendations based on each selected abstract. The study protocol was conducted according to the PRISMA (preferred reporting items for systematic reviews and meta-analyses)¹² Guidelines.

2.1 | Eligibility criteria and quality assessment

JWBMN and FIBM reviewed all the retrieved articles’ abstracts. Selection for full-text evaluation required the following criteria be met: (a) minimum of two groups included (prone or jack-knife vs classic, lithotomy or Lloyd-Davis position); (b) detailed description of surgical technique provided; (c) at least one outcome of interest must have been reported; and (d) clear definition of the target population and recruitment period. Studies were excluded from the analysis if their abstract or full text met one or more of the following criteria: (i) nonoriginal research or absence of control group; (ii) studies aiming to evaluate the outcomes of ELAPE without specific patient positioning analysis; (iii) routine use of prosthetic or autologous flaps to close the perineal wound; (iv) routine coccyx or sacral resection, despite absence of tumor invasion; and (v) studies with overlapping or duplicate cohorts.

2.2 | Variables and outcomes of interest

Short-term outcomes were extracted from the perioperative data and included: estimated blood loss (EBL), OT, PWI, and 30-day mortality. Oncological outcomes included circumferential resection margin (CRM) positivity, 5-year local recurrence rates, and 5-year overall survival. To increase reliability, we excluded from the analysis variables reported in less than three studies. In addition to the outcome variables, the authors also recorded patients’ demographics, tumor characteristics, number of different surgeons performing the operations, follow-up status and length of stay.

2.3 | Statistical analysis

The authors reviewed all the selected articles and extracted the data into a spreadsheet using the Excel 2010 software (Microsoft Corporation, Redmond, WA). The data analysis was done using the software Review Manager 5.3 (Cochrane Community, London, UK). Continuous variables from each study were recorded by using the difference of means between the two groups, as well as their dispersion measures. SD was directly extracted from each study or converted from the standard error (SE) when only SE had been reported. Three studies presented their numeric outcomes using median and interquartile range (IQR) only. To include these in our pooled data analysis, we extracted the mean and SD using the mathematical method proposed by Wan.¹³ We only proceeded with the statistical analysis of the outcomes reported in at least three studies. Therefore, 5-year overall survival was removed from the final analysis. Pooled numeric variables were analyzed using the inverse-variance (IV) method, consequently attributing more weight to the studies with narrower confidence intervals. The effect size was measured by the difference of means (DM) between the two groups with a 95% confidence interval (95% CI). Dichotomous outcomes were recorded by using the absolute number of events and analyzed by the Mantel-Haenszel method. The effect size of the categorical variable outcomes was expressed by odds ratio (OR) with 95% CI.

Heterogeneity was calculated by the Cochran's χ^2 method and I^2 statistic. A conservative P value of 0.10 was elected to refute homogeneity and studies with an I^2 score less than or equal to 60% were considered of low heterogeneity. To minimize the bias resulting from the clinical heterogeneity (different tumor characteristics, populations from several countries, and the lack of a standardized surgical technique),¹⁴ we adopted the random-effect model for data analysis throughout the meta-analysis.¹⁵ A Forest plot chart was created and reported for each analyzed variable.

3 | RESULTS

Our initial search returned 148 results, and three other studies were included based on PubMed related recommendations. 119 abstracts were selected for review following the exclusion of duplicate records. Ninety-nine abstracts did not meet the inclusion criteria and were removed. A total of 18 studies were selected for further full-text analysis. Finally, six titles were included in the final analysis and the remaining 12 were excluded due to the following reasons: PICO questions were not addressed in the study (six), lack of comparison group (two), overlapping cohorts (one), lack of the details regarding the patient positioning (one), use of lateral instead of prone position (one), and routine bone resection and flap for reconstruction (one) (Figure 1).

The final analysis included 1663 patients from four different countries, 788 in the P-APR and 841 in the C-APR group. At least 41 different surgeons performed the operations. All articles were published within the last 7 years and were retrospective cohorts extracted from prospectively maintained databases. Characteristics of the select studies are summarized in Table 1.

3.1 | Perioperative outcomes

Four studies ($n = 902$) reported the OT. P-APR group had significantly shorter OT (DM, -43.8 minutes; 95% CI, $[-61.94$ to $-25.66]$; $P < 0.01$) as compared to the C-APR group (Figure 2A). EBL was reported in three studies ($n = 743$), with the P-APR group showing a significant decrease in blood loss (DM, 86.98 mL; 95% CI, $[98.88-75.9]$; $P < 0.01$) (Figure 2B). PWI rate was reported in three studies ($n = 734$), and the difference between the two groups was not significant (OR, 0.36 ; 95% CI, $[0.08-1.61]$; $P = 0.18$) (Figure 2C).

The rate of intraoperative (iatrogenic) tumor perforation was reported by six authors ($n = 1356$), and the difference of IOP between the groups was not statistically significant (OR, 0.98 ; 95% CI, $[0.37-2.60]$; $P = 0.97$) (Figure 2D). The format used to report the overall complication rate was inconsistent throughout the studies and precluded the analysis of this outcome.

3.2 | Pathologic and oncological outcomes

CRM was defined as the presence of tumor within less than 1 mm of the resection margin. Data from the six studies ($n = 1319$) which reported CRM showed no difference between the two groups (OR, 1.02 ; 95% CI, $[0.34-3.00]$; $P = 0.98$) (Figure 3A). The 5-year-recurrence rate was reported by six studies ($n = 1,479$) and was also not significantly different between the groups (OR, 1.00 ; 95% CI, $[0.61-1.66]$; $P = 0.99$) (Figure 3B). 5-year-overall survival data was reported by two studies only and was excluded from the meta-analysis according to our previously established protocol.

3.3 | Quality assessment and risk of bias

All seven included studies were retrospective. Heterogeneity was present in most of the analyzed outcomes, with I^2 score ranging from 0% to 81%; only EBL (I^2 , 0%; $P = 0.72$) and recurrence rate (I^2 , 43%; $P = 0.12$) were considered homogenous. Of note, per protocol, the random-effects method was still used for analysis for the latter variables due to the assumed clinical heterogeneity of the studies. A seven-point risk of bias graph as per the author's judgments is provided in Figure 4.

4 | DISCUSSION

This meta-analysis was designed to evaluate whether surgical positioning (prone or lithotomy) can affect the perioperative and oncological outcomes after APR for RC. Overall, the meta-analysis of the pooled data showed no difference in tumor recurrence or margin positivity. Regarding the perioperative endpoints, the P-APR group had decreased OT and EBL when compared with the C-APR group. However, this did not translate to decreased rectal perforation rates or a fewer number of PWI.

In 2007, Holm⁶ published his original description of the extended APR and reported improved oncological results following cylindrical resection utilizing the prone position. Subsequent studies reported similar outcomes^{4,22} with decreased blood loss and OT despite the extended resection. These improved perioperative results were partially attributed to the use of the prone position, which allegedly provided a more straightforward approach to the

perineal anatomic structures. In the Lloyd-Davis position, blood tends to accumulate in the operative field and it is difficult to obtain adequate exposure. Moreover, the surgeon's and especially the assistants' positions are uncomfortable, making hemostasis challenging and dissection laborious. Notwithstanding the fact P-APR requires patient repositioning, Liu et al¹⁰ reported that the median time to complete this step is only 18 minutes, and the benefit of the better exposure overcompensates for this extra step. Indeed, a pooled analysis showed that the prone approach can significantly decrease the OT by 43 minutes (Figure 2A). In tandem with this, the EBL was also significantly decreased by 86 mL in the C-APR group. The clinical significance of this difference in the EBL is more problematic to analyze, since we do not have data to assess if this was associated with an increased number of blood transfusions or its related complications. As OT and EBL are intrinsically related, it is reasonable to infer that the improvement in the intraoperative hemostatic control contributed to a decreased OT.

PWI with subsequent perineal dehiscence is a frequent complication after APR, and to date, there is not yet an optimal approach or surgical technique to decrease perineal infections. Some authors have advocated that the prone position leads to decreased PWI. However, our pooled data showed no statistical significance for PWI using the random-effects method (OR, 0.36; 95% CI, [0.08–1.61]; $P=0.18$). Although, when analyzed using the fixed-effect model, the prone position seems to decrease the incidence of PWI (OR, 0.45; 95% CI, [0.26–0.78]; $P=0.004$). The discrepancy of these results can be at least in part explained after careful analysis of the available data.

Dinaux et al²¹ reported their experience with P-APR and showed that the prone position decreased the rates of perineal infection at their institution (OR, 9.18; 95% CI, [1.96–43.0]). However, when the performing surgeon was included in their multivariate analysis, there were no significant differences in PWI (supine vs prone; OR, 1.52; 95% CI, [0.26–8.97]; $P=0.642$) or overall perineal wound complications (supine vs prone; OR, 4.22; 95% CI, [0.71–25.16]; $P=0.114$). As the fixed-effect assumes homogeneity and attributes different weight to studies, this may explain why the position seems to decrease the rates of PWI when only using the fixed-effect model in our meta-analysis.

The operating surgeon being one of the determinants of the incidence of wound infection has been suggested previously,²³ and Dinaux et al²¹ acknowledge that it may be a confounder in their study, especially because the positioning is usually dependent on surgeon's personal preference. Nonetheless, they believe this does not mitigate the importance of the positioning, as their data suggest that routine adoption of the prone position may obviate the performing surgeon from being a risk factor for wound complications.

From a different perspective, De Campos-Lobato et al¹⁶ showed no difference in PWI between the P-APR and C-APR groups at their institution, which they attribute to the use of standardized surgical technique regardless of the patient positioning, and the fact that all surgeons had previous postgraduate training in rectal surgery. In our meta-analysis, we used the random-effect method and it showed that the prone position per se does not reduce the rate of PWI. Indeed, it is reasonable to infer that consistent use of a standardized surgical

technique rather than the positioning is probably the key to achieving fewer local complications and will likely mitigate the impact of the surgeon and positioning.

Regarding intraoperative perforation, a recent meta-analysis showed that the ELAPE carried out in a prone position decreases the rates of IOP (OR, 0.39; 95% CI, [0.22–0.68]).⁹ When we addressed the impact of the positioning per se, we did not observe differences in the incidence of IOP between the two groups.

The proponents of the ELAPE advocate that the cylindrical resection dramatically decreases the CRM positivity,⁴ and this has led those in favor of the prone position to point the better exposure as a contributor to better local control.¹⁰ However, even for ELAPE, CRM is only a surrogate marker of local control, and its clinical impact on recurrence and survival is less clear. Our CRM analysis included 1319 patients and we did not observe differences between the two groups (OR, 1.00; 95% CI, [0.61–1.66]). Not surprisingly, a prone position also did not alter the recurrence rates (OR, 0.65; 95% CI, [0.21–2.00]). Although we intended to analyze the long-term survival rates, we could extract 5-year overall survival data from only two studies, and the variable was not included in the meta-analysis per the protocol. However, among the myriad of clinical factors that are determinants of long-term prognosis, such as tumor staging and neoadjuvant treatment, positioning does not seem to play a significant role in outlook.

We acknowledge that our study has some important limitations. Firstly, all the available data is retrospective and none of the patients were randomized to any treatment group. Secondly, despite our efforts to exclude all the ELAPE cases, we acknowledge that some of the patients included in the P-APR group may have undergone an extended APR, which could affect the conclusions drawn for the impact of position per se. As an attempt to alleviate this limitation, we excluded all studies which described routine bone resection or the use of local laps for perineal closure. As the problems are intrinsic to the retrospective and nonrandomized nature of the studies, this only highlights the necessity of conducting a randomized prospective study with long-term follow-up.

In conclusion, (i) for patients undergoing an APR, is there a difference in immediate perioperative outcomes based on whether they were in the prone or lithotomy position? The prone position is associated with decreased blood loss and decreased OT, although not with any change in the incidence of infection or intraoperative perforation; (ii) in patients with rectal cancer undergoing an APR, is there a difference in recurrence rate or survival between patients in the prone or lithotomy position? There appears to be no difference in recurrence rate or survival between patients in the prone or lithotomy position. Overall, the data suggest that a standardized technique with adequate training is more important than surgical positioning and that the use of one method over another should be left to the surgeon's preference.

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FIGURE 1.
PRISMA flow diagram depicting a literature search and included studies

(A) Operative time: P-APR versus C-APR

(B) Estimated blood loss: P-APR versus C-APR group

(C) Perineal wound infection: P-APR versus C-APR

(D) Intraoperative perforation: P-APR versus C-APR

FIGURE 2.

Forest plot showing the perioperative outcomes in P-APR vs C-APR groups. A, Operative time: P-APR vs C-APR. B, Estimated blood loss: P-APR vs C-APR group. C, Perineal wound infection: P-APR vs C-APR. D, Intraoperative perforation: P-APR vs C-APR. C-APR, classic abdominoperineal resection; P-APR, prone abdominoperineal resection

(A) Circumferential resection margins positivity: P-APR versus C-APR

(B) 5-year local recurrence: P-APR versus C-APR

FIGURE 3.

Forest plot chart showing the oncological outcomes in P-APR vs C-APR groups. A, Circumferential resection margins positivity: P-APR vs C-APR. B, 5-year local recurrence: P-APR vs C-APR. C-APR, classic abdominoperineal resection; P-APR, prone abdominoperineal resection

FIGURE 4.
Risk of bias graph with author's judgments about each risk of bias across all studies

TABLE 1

Study characteristics and results

Author (location)	Design	Sample (N)	Follow-up (months)	Outcomes	Results
De Campos-Lobato et al ¹⁶ (the United States)	NRC	P-APR: 81 C-APR: 87 Total: 168	42	OT, EBL, PWI, CRM, LR, IOP	Prone and lithotomy positions were not different regarding tumor recurrence, IOP and perioperative morbidity. OT was shorter for P-APR (102 vs 208; $P < 0.05$).
Tayyab et al ¹⁷ (the United States)	NRC	P-APR: 58 C-APR: 63 Total: 121	33 (P-APR) 53 (C-APR)	CRM, LR, IOP	5-y local recurrence was lower in the P-APR group (5% vs 23%; $P < 0.03$). CRM and perforation did not differ between the two groups.
Showalter et al ¹⁵ (the United States)	NRC	P-APR: 36 C-APR: 114 Total: 130	11.4	PWI, EBL, OT	PWI was lower in the P-APR group (11% vs 36%; $P < 0.05$). OT and EBL were significantly decreased, though SD, SE, or IQR not reported.
Anderin et al ¹⁸ (Sweden)	NRC	P-APR: 249 C-APR: 217 Total: 466	28.8 (P-APR) 50.4 (C-APR)	CRM, LR, IOP	IOP was lower in the P-APR group (4% vs 12.4%; $P < 0.001$). LR difference was not statistically significant.
Hu et al ¹⁹ (China)	NRC	P-APR: 293 C-APR: 243 Total: 536	62	OT, EBL, LR, IOP	OT (3.10 vs 3.8 h) and EBL (124 vs 210 mL) were decreased in the P-APR group. P-APR was associated with a lower recurrence rate (5.5% vs 11.9%; $P < 0.001$). CRM did not differ between groups.
Park et al ²⁰ (South Korea)	NRC	P-APR: 13 C-APR: 26 Total: 39	NR	OT, EBL, LR, IOP, CRM	C-APR achieved improved OT (285 vs 355 min) and EBL (300 vs 360 mL). IOP and CRM were not statistically significant between the groups.
Dinaux et al ²¹ (the United States)	NRC	P-APR: 58 C-APR: 91 Total: 149	NR	OT, PWI, CRM, LR, IOP	OT was shorter in the P-APR (163 vs 228 min). PWI was lower in the P-APR group (3% vs 22%; $P < 0.05$). CRM and IOP did not differ between groups.

Abbreviations: C-APR, classic abdominoperineal resection; CRM, circumferential resection margins; EBL, estimated blood loss; IOP, intraoperative perforation of rectum; LR, local recurrence; NRC, nonrandomized retrospective cohort; OT, operative time; P-APR, prone abdominoperineal resection; PWI, perineal wound infection.