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Original Research Article

Impact of Intraoperative Hypothermia on Early Postoperative Anastomotic Leak in Patients Undergoing Elective Colorectal Surgery

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Abstract: ***Background:*** Anastomotic leak is a severe complication after elective colorectal surgery that leads to the enhanced morbidity, mortality, and extended hospitalization. One of the most typical, potentially manipulable, aspects that can negatively affect tissue repair and predispose to anastomotic complications is intraoperative hypothermia. ***Objective:*** To determine the effect of intraoperative hypothermia on early postoperative anastomotic leakage in individuals undergoing elective colorectal surgery. ***Methods:*** This prospective cohort was a study that involved 180 adult patients undergoing elective colorectal resection and primary anastomosis at between the 1st November 2024 to 30th April 2025. Intraoperative monitoring of core temperature was used to identify patients as hypothermic (<36 C) or normothermic (≥36 C). The data were analyzed with the help of SPSS 26, t-test or Mann-Whitney U test were used when the variables were continuous, and chi-square or Fisher exact test were used when the variables were categorical. Adjusted confounder multivariate logistic regression. ***Results:*** A total of 180 patients already had intraoperative hypothermia (78 out of 180, 43.3%). Early anastomotic leakage was more prevalent in the hypothermia group and hypothermia was predictive in independently adjusting variables of age, body mass index, ASA score, operative time, and blood loss. Other perioperative variables were similar in both groups. ***Conclusion:*** Hypothermia during the operation is a significant risk factor of early postoperative anastomotic leak in elective colorectal surgery. Perioperative vigilant temperature control is an easy, practical, and adjustable intervention to improve anastomotic healing and patient outcomes

Keywords: Colorectal surgery, Anastomotic leak, Intraoperative hypothermia, Prospective cohort, Postoperative complications.

INTRODUCTION

Colorectal surgery is widely conducted to cure a broad range of benign and malignant gastrointestinal diseases and is associated with significant morbidity in the postoperative period.[1] Despite the innovation in the

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surgical practices, perioperative care, and improved recovery measures, anastomotic leak (AL) is one of the most dreaded and severe complications after colorectal resection.[2] In addition to raising postoperative morbidity and mortality, anastomotic leakage prolongs the hospital stay and increases the costs of care, and negatively impacts long-term oncological results and quality of life.[3]

The incidence of anastomotic leak (AL) following elective colorectal surgery is reported to be between 3% and 15%, depending on patient factors, surgery method, level of anastomosis, and perioperative care.[4] The mortality rates of AL can be up to 10%-20%, especially among older patients and patients with comorbidities.[5] They have identified several risk factors of AL, such as malnutrition, smoking, steroid use, poor tissue perfusion, tension at the anastomotic site, and intraoperative hemodynamic instability. Nonetheless, there are potentially adjustable perioperative factors that are gaining more clinical focus.[6]

A common yet underappreciated complication of a major abdominal surgery is intraoperative hypothermia, or core body temperature reaching or falling below 36 °C.[7] Research indicates that approximately 50-70% of patients who have long-term abdominal surgeries develop certain levels of unwanted hypothermia.[8] Hypothermia has been demonstrated to disrupt coagulation, hinder tissue oxygenation, silence immune activity, and weaken collagen production, biologically plausible mechanisms that have been shown to contribute to poor anastomotic healing.[9] Regardless of these associations, the direct effect of intraoperative hypothermia on early postoperative anastomotic leak has not been adequately investigated, especially in elective colorectal surgery.[10]

Since intraoperative hypothermia is a preventable and reversible risk factor, a better comprehension of its contribution to anastomotic integrity is of a high clinical interest. Knowing a definite relation between intraoperative hypothermia and anastomotic leak may affect the perioperative temperature management behavior and lead to a better outcome. Nevertheless, the current literature is sparse and without conclusive results, and specialized clinical assessment of the field is necessary. The current investigation attempted to determine the effect of intraoperative hypothermia on early postoperative anastomotic leak in patients undergoing elective colorectal surgery.

MATERIAL AND METHODS

The study was a prospective cohort study that was undertaken to determine the interaction between intraoperative hypothermia and early postoperative anastomotic leak in patients who underwent elective colorectal surgery. This research was conducted in the Department of General Surgery. The research period was six months, between 1st November 2024 to 30th April 2025. The patients were recruited in a consecutive manner and monitored, since surgery, until the first 30 days of the postoperative period to develop clinically and radiologically verified anastomotic leaks.

The sample was estimated with the OpenEpi sample size module of cohort studies with an approximate incidence of anastomotic leak in the baseline of elective colorectal surgery at 8-10% as per the published literature. A number of studies show that leakage rate of anastomosis following colorectal resection has a varied range though most of the reports have recorded 3%-14% with regard to patient and operative variables.[11] The estimated total sample size was about 180 patients (90 patients in each of the exposure arms: hypothermia vs. normothermia) in order to reveal a risk ratio of at least 2.0 in changes related to intraoperative hypothermia at 95% confidence level and 80% power.

Non-probability consecutive sampling was used to select patients, whereby, all eligible patients which came forward during the study period were used to sample until the required sample size was obtained. Inclusion criteria: grown-up patients who had benign or malignant disease as primary anastomosis and who were receiving elective colonic resection, and could consent to participate. Exclusion criteria were: emergency surgery, patients undergoing resection without an initial anastomosis, laparoscopic to open conversion because of intraoperative complications which were not related to temperature, known connective tissue disorders, immunosuppressive treatment and those with incomplete intraoperative temperature records.

Thorough data collection processes were used. Baseline demographic and clinical data such as age, sex, BMI, comorbidity, smoking history, ASA score, surgery indication and preoperative laboratory were documented on a structured proforma after permission. The continuous monitoring of intraoperative core body temperature was through esophageal or nasopharyngeal temperature probe after induction of anesthesia up to surgical closure. Patients were classified as hypothermic when their lowest minimum intraoperative core temperature dropped below 36.0 -1 at any time during the operation, and as normothermic when temperatures did not drop below 36.0 -1 at any time during the operation. Additional intraoperative variables which included surgical method (open/laparoscopic), length of surgery, estimated blood

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loss, fluid administration and use of warming devices were recorded.

All patients were monitored in their hospitals on a daily basis after surgery and through outpatients or telephone follow up within a period of 30 days after surgery. The definition of early postoperative anastomotic leak was based on both clinical (fever, abdominal pain, peritonitis) and radiologic (leak evidence on contrast-enhanced CT or contrast enema) evidence of this leak. Also included were cases that needed radiologic intervention or re-operation of anastomotic leakage. Two independent investigators cross-checked clinical records and radiology reports in order to guarantee quality.

To analyze the data, all the information obtained was keyed and analyzed via SPSS version 26 (IBM Corp.). The means and standard deviations or the median (interquartile ranges) in continuous variables were summarized according to the distribution, and the percentages and frequencies in the categorical variables. Patients were pooled according to intraoperative temperature (hypothermia and normothermia). Student t-test was used to compare baseline and perioperative characteristics of the two groups, which are continuous variables, and chi-square test was used to compare categorical variables. The main outcome, which was the incidence of early anastomotic leak, was compared between the groups, and relative risks (RR) with 95% confidence intervals were determined. The multivariate analysis was done by use of the logistic regression to control the possible confounders, which include age, BMI, ASA score, duration of surgery, and blood loss. The level of statistical significance was defined as a p-value ≤0.05.

RESULTS

The study involved 180 patients; among them, 78 (43.3) patients had intraoperative hypothermia and 102 (56.7) patients had normothermia. Both groups were similar in regard to baseline demographic/ clinical factors such as age, sex distribution, BMI, comorbidities, ASA classification, and smoking history, which did not show significant preoperative differences that could confound the main outcome (Table 1).

There was also a general similarity in perioperative variables among the two groups. The majority of the patients were subjected to open surgery, and laparoscopic operations were balanced in distribution. Even though the duration of surgery was also a little higher in the hypothermia group, there were no significant differences in other intraoperative aspects, including estimated blood loss and total fluid intake (Table 2).

The cases of early postoperative anastomotic leak were more prevalent in patients who experienced intraoperative hypothermia than in normothermic patients. In the same manner, reoperations involving leaks were higher in the hypothermia group, but 30-day mortality did not have significant differences between the groups (Table 3).

In multivariate logistic regression analysis, intraoperative hypothermia remained an independent predictor of early anastomotic leak after the adjustment of possible confounders, such as age, BMI, ASA class, duration of surgery, and estimated blood loss (Table 4). The independent relationship between other variables and the risk of leak was not significant.

Perioperative variables that were continuous over time, including age, BMI, duration of operation, estimated blood loss, intraoperative fluid, and minimum intraoperative temperature, were summarized and compared between the two groups. The duration of surgery and minimum core temperature showed significant differences, with the finding that hypothermia was related to longer surgery and lower intraoperative temperature without significant differences in other variables (Table 5).

Table 1. Baseline Demographic and Clinical Characteristics of Patients

Characteristic	Hypothermia (n=78)	Normothermia (n=102)	p-value
Age (years), mean ± SD	57.4 ± 12.3	55.8 ± 11.7	0.35
Sex (Male), n (%)	44 (56.4%)	58 (56.9%)	0.95
BMI (kg/m²), mean ± SD	26.2 ± 4.1	25.8 ± 3.9	0.48
ASA Class III, n (%)	18 (23.1%)	20 (19.6%)	0.53
Smoking history, n (%)	28 (35.9%)	32 (31.4%)	0.53
Diabetes Mellitus, n (%)	14 (17.9%)	18 (17.6%)	0.96
Hypertension, n (%)	22 (28.2%)	26 (25.5%)	0.70

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Table 2. Perioperative Characteristics

Variable	Hypothermia (n=78)	Normothermia (n=102)	p-value
Duration of surgery (min), mean ± SD	185 ± 42	172 ± 38	0.03*
Estimated blood loss (ml), mean ± SD	320 ± 110	290 ± 95	0.08
Open surgery, n (%)	54 (69.2%)	66 (64.7%)	0.52
Laparoscopic surgery, n (%)	24 (30.8%)	36 (35.3%)	0.52
Intraoperative fluid (ml), mean ± SD	2100 ± 450	2050 ± 410	0.46
*Statistically significant (p < 0.05)			

Table 3. Early Postoperative Anastomotic Leak

Outcome	Hypothermia (n=78)	Normothermia (n=102)	Relative Risk (95% CI)	p-value
Anastomotic leak, n (%)	12 (15.4%)	5 (4.9%)	3.14 (1.12–8.79)	0.02*
Reoperation due to leak, n (%)	6 (7.7%)	2 (2.0%)	3.85 (0.83–17.80)	0.08
30-day mortality, n (%)	2 (2.6%)	1 (1.0%)	2.60 (0.25–27.00)	0.39
*Statistically significant (p < 0.05)				

Table 4. Multivariate Logistic Regression for Anastomotic Leak

Variable	Adjusted OR	95% CI	p-value
Intraoperative hypothermia	3.12	1.05–9.26	0.04*
Age (per year increase)	1.01	0.97–1.05	0.61
BMI (per unit increase)	1.05	0.97–1.14	0.23
ASA Class III vs I-II	1.42	0.48–4.19	0.53
Duration of surgery (>180 min)	1.88	0.72–4.92	0.20
Estimated blood loss (>300 ml)	1.62	0.63–4.18	0.32
*Statistically significant (p < 0.05)			

DISCUSSION

In the present prospective cohort study, patients having intraoperative hypothermia had a considerably increased rate of early postoperative anastomotic leak following an elective colorectal operation than normothermic patients. Intraoperative hypothermia was also an independent predictor of anastomotic leakage after correction of possible confounding factors like age, BMI, ASA score, operative duration, and blood loss, and this indicates how intraoperative hypothermia could be considered a modifiable perioperative variable.

Our results are aligned with an increasing amount of evidence indicating that perioperative temperature control has an impact on surgical outcomes. A recent prospective observational study of patients undergoing rectal surgery reported intraoperative hypothermia as a risk of early anastomotic leakage and excessive inflammatory markers (e.g., IL 17), suggesting biological processes that associate hypothermia with poor tissue healing and inflammatory processes (e.g., suppressed immune response and collagen deposition), which can weaken anastomotic integrity.[12]

Most studies on intraoperative hypothermia have been done on non-colorectal surgery, but the patterns are consistent. As an example, a multicentric study of esophagectomy patients revealed that lower intraoperative temperature was associated with significantly higher risks of postoperative anastomotic failure, such as leaks and severe morbidity, which confirms the hypothesis that hypothermia negatively affects anastomotic healing in various gastrointestinal operations.[13] A similar investigation involving Ivor Lewis esophagectomy revealed that the only independent predictor of anastomotic leak on a multivariate analysis was severe intraoperative hypothermia (<35 o C).[14] These studies are in non-colorectal populations, but the studies point in the right direction as they indicate the general applicability of temperature control in anastomotic surgeries.

In colorectal surgery specifically, the DoubleCheck trial focused on modifiable intraoperative risk factors such as hypothermia and found that perioperative optimisation

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decreased the incidence of colorectal anastomotic leak, although not exclusively due to the use of temperature control.[15] This is consistent with our discovery of the link between hypothermia and leak risk but underscores the idea that more complex perioperative care packages can be required to achieve leak reduction.

In addition to anastomotic leak, the perioperative outcomes of hypothermia have been reported to have more extensive negative consequences. A 2025 meta-analysis of the literature in BMC Anesthesiology discovered an effect of low body temperature (intraoperative hypothermia) with a tendency towards increased risk of surgical site infection, particularly when the body temperature was reduced to ≤35 °C or below, which could be an indirect factor in impaired wound and anastomotic healing.[16] Equally, hypo or normothermia has been associated with increased duration of hospitalization and other postoperative complications among general surgery patients, which suggests that temperature deregulation has systemic consequences related to recovery.[17]

The concept that hypothermia is a negative influence on surgical outcomes is also supported by research conducted on other forms of abdominal anastomoses. As an example, clinically relevant postoperative pancreatic fistula after pancreaticoduodenectomy was greater in cases of severe intraoperative hypothermia, indicating that hypothermia can have a wide-range of deleterious effects on anastomotic healing in digestive tract surgery.[18] A related retrospective study revealed hypothermia to be linked with pancreatic fistula following PD, which once again affirms this deleterious association.[19]

Even though work in reconstructive surgery does not directly measure anastomotic leaks, studies have demonstrated that intraoperative hypothermia elevates the rates of wound complications, hematoma, and impaired healing, which then supports the mechanistic plausibility of hypothermia impacting tissue repair.[20] However, other historical meta-analyses, primarily of superficial surgical complications, have also shown mixed evidence, no significant overall relationship between hypothermia and poor outcome in all forms of surgery, but significant risk at temperatures below certain critical values, or in specific operations.[16] The results indicate a multifaceted and contextualized role of intraoperative temperature with significant effects, especially in major abdominal and anastomotic surgery.

Along with hypothermia, both the demographic and perioperative profiles of your cohort were typically reflective of other colorectal anastomotic leak studies where multifactorial risk profiles such as operative time, comorbidity, and immunologic status have been implicated.[21] Although the studies did not necessarily explicitly address the use of temperature, they reiterated the complexity of anastomotic complications and how the inclusion of temperature monitoring in perioperative risk assessment may be advantageous.

The strengths of our study are a prospective study design, core temperature measurements, and multivariate adjustment of core temperature measurements with the most important confounders that provided strong evidence that intraoperative hypothermia is an independent predictor of anastomotic leak. This is clinically significant because of the need to be more vigilant in ensuring intraoperative warming protocols (e.g., forced air warming, fluid warming) are affordable and modifiable protocols to enhance surgical outcomes. Although there have been constant associations, causal inference is also hampered by observational design. Also, the lack of universal temperature thresholds and heterogeneity of definitions of hypothermia across studies make it more difficult to directly compare studies, and larger multicenter prospective and interventional studies are warranted.

Conclusion

The significance of intraoperative hypothermia is a predictive factor and an independent one in the early occurrence of anastomotic leak in elective colorectal surgery patients. Normothermia in surgical practice helps to minimize the likelihood of this dangerous complication, as well as to promote the healthy growth of tissues and the overall recovery of the patient after surgery. These results highlight the importance of close integration of perioperative temperature as a basic, inexpensive, and adjustable intervention to enhance surgical outcomes. Active warming and continuous monitoring of core temperature should be seen as routine practice when performing elective colorectal surgeries to improve patient safety and minimize postoperative morbidity.

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