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Original Research Article

A prospective observational study to predict risk factors for post operative gastrointestinal anastomotic leakage by using evaluation of physiological ability and surgical stress scoring system in S. M. S. Hospital, Jaipur

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ABSTRACT

Background: Anastomotic leakage is a major complication of gastrointestinal surgery. The Estimation of Physiological Ability and Surgical Stress (E-PASS) scoring system combines preoperative physiological reserve and intraoperative surgical stress to predict postoperative outcomes. This study evaluated its ability to predict anastomotic leakage and mortality in a North Indian tertiary care centre.
Methods: This prospective observational study included 60 patients aged over 15 years undergoing elective or emergency gastrointestinal anastomosis at S. M. S. Medical College, Jaipur. Preoperative Risk Score (PRS), Surgical Stress Score (SSS) and Comprehensive Risk Score (CRS) were calculated. Patients were followed for 14 days. Statistical significance was set at $p<0.05$.
Results: Anastomotic leakage occurred in 4 patients (6.7%), between postoperative days 4 and 8. Patients with leakage had significantly higher mean CRS (0.899±0.041 vs 0.213±0.278; $p<0.001$) and PRS (0.990±0.111 vs 0.325±0.341; $p<0.001$). SSS showed no significant difference ($p=0.162$). A CRS ≥0.9 demonstrated 75% sensitivity, 100% specificity, 100% positive predictive value and 98.2% negative predictive value. Leakage was associated with two or more major comorbidities ($p=0.020$). One patient (1.7%) died.
Conclusions: E-PASS, particularly CRS, may help identify patients at increased risk of anastomotic leakage. Preoperative physiological vulnerability appears to contribute more substantially than intraoperative surgical stress.

Keywords: Anastomotic leakage, E-PASS, Gastrointestinal surgery, Surgical risk prediction, Comprehensive risk score, Tertiary care

INTRODUCTION

Anastomotic leakage is among the most consequential complications in gastrointestinal surgery, transforming a routine recovery into a cascade of sepsis, reoperation, prolonged hospitalisation and, in severe cases, death.[1,2] Reported leak rates vary from 0.5% to 30% depending on anastomotic site, patient population and definition used, with colorectal and oesophageal anastomoses at the higher end of this range.[3] Beyond its acute morbidity, leakage roughly doubles the cost and duration of hospitalisation and compromises long-term oncological outcomes in cancer surgery.[4]

A recurring difficulty for the operating surgeon is that the decision to complete a primary anastomosis versus defer to a staged procedure with temporary diversion is made largely on clinical judgement, which is experience-dependent, subjective and difficult to standardise. Existing composite scores such as POSSUM and P-POSSUM were

designed for global postoperative morbidity/mortality prediction rather than anastomotic healing specifically, and single biomarkers such as albumin, while informative, do not yield an actionable composite number.[5]

The E-PASS system, first described by Haga et al was developed specifically for gastrointestinal surgery.[6,15] It comprises a PRS (PRS, derived from age, cardiac and pulmonary disease severity, diabetes, ECOG performance status and ASA grade), a (SSS, derived from blood loss per kilogram, operative duration and incision extent), and a CRS (CRS=-0.328+0.936×PRS+0.976×SSS) that combines both.[13] A CRS threshold near 0.9 has been proposed in prior work as a marker of substantially elevated leakage and mortality risk, most notably in a seed study from RIMS Ranchi in which CRS >0.9 was associated with 78.6% of leaks.[7,14] Whether this threshold, and E-PASS more broadly, performs similarly in other North Indian tertiary settings-characterised by a high burden of emergency surgery, undertreated comorbidity and nutritional depletion-has not been established. We therefore prospectively evaluated E-PASS in patients undergoing gastrointestinal anastomosis at a large public teaching hospital in Rajasthan.

METHODS

Study design and setting

This was a hospital-based, prospective, observational study conducted in the Department of General Surgery, S.M.S. Medical College and Attached Hospitals, Jaipur, following approval by the Institutional Ethics Committee (Ref. MC/EC/2024). All patients provided written informed consent. The study was conducted from August 2024 to August 2025

Participants

Consecutive patients aged over 15 years undergoing bowel anastomosis in elective or emergency settings were enrolled. Patients undergoing stoma reversal, relaparotomy, or pancreaticoduodenectomy, and immunocompromised patients (HIV infection, or on corticosteroids/chemotherapy), were excluded.

Sample size

Sample size was calculated using an anticipated leakage prevalence of 16% (based on the RIMS Ranchi seed study), 95% confidence and 10% absolute allowable error ($n = Z^2pq/d^2$), giving a minimum requirement of 52 patients; this was inflated by 10% for attrition to a final target of 60 patients.

E-PASS calculation and outcomes

PRS, SSS and CRS were calculated for each patient using the standard E-PASS formulae from preoperative clinical/laboratory parameters and intraoperative data (blood loss per body weight, operative duration, incision extent). Patients were followed for 14 days postoperatively for the primary outcome of anastomotic leakage (clinical, radiological or on re-exploration) and the secondary outcome of mortality.

Statistical analysis

Data were analysed in SPSS v26.0. Continuous variables are expressed as mean±SD and compared with the independent-samples t test; categorical variables were compared using the chi-square or Fisher's exact test as appropriate. Diagnostic performance of CRS ≥0.9 was expressed as sensitivity, specificity, positive and negative predictive value. A two-sided $p<0.05$ was considered statistically significant.

RESULTS

Sixty patients (mean age 42.2±15.8 years, range 18-71) were enrolled; 39 (65.0%) underwent emergency and 21 (35.0%) elective surgery. Anastomotic leakage occurred in 4 patients (6.7%), presenting between postoperative day (POD) 4 and POD 8, consistent with the expected nadir of anastomotic tensile strength. One patient (1.7%) died; this was the same patient who developed leakage, on POD 7, with a CRS of 1.118.

Table 1: Baseline characteristics and anastomotic leakage rate by clinical category.

Variables	N	With leak, N (%)	P value
Age ≥51 years	20	4 (20.0)	0.010
ASA grade III-IV	13	3 (23.1)	0.029
ECOG performance status 2	10	3 (30.0)	0.013
Ischaemic heart disease	8	3 (37.5)	0.006
Pulmonary disease	9	3 (33.3)	0.009
Diabetes mellitus	18	4 (22.2)	0.006
No major comorbidity	38	0 (0.0)	0.015
Prolonged operative time (≥3 h)	17	3 (17.6)	0.065 (NS)
Elevated blood loss (>10 g/kg)	31	3 (9.7)	0.613 (NS)

*NS-not significant.

Leakage occurred exclusively in patients aged ≥51 years and was strongly associated with ASA grade, ECOG performance status, and individual comorbidities (Table 1). Notably, every leakage patient had diabetes mellitus, making it the single most consistent individual risk factor; heart and pulmonary disease were each present in only two of the four leak patients, always alongside at least one other major comorbidity. When comorbidity burden was grouped, leakage occurred in 4/10 (40.0%) patients with two or more of diabetes, ischaemic heart disease or pulmonary disease, compared with 0/14 with a single

comorbidity and 0/36 with none (Fisher's exact, p=0.020)-indicating that clustering, rather than any single diagnosis, drove leakage risk. Intraoperative parameters (operative time, blood loss) were numerically higher in the leak group but did not reach significance.

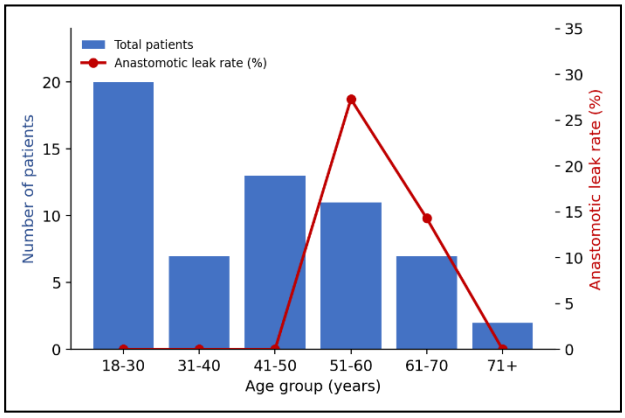


Figure 1: Age group distribution of the study population with anastomotic leakage rate by age group.

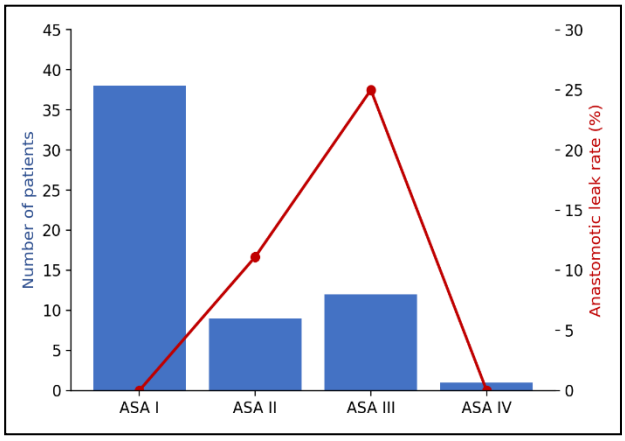


Figure 2: ASA grade distribution with corresponding anastomotic leakage rate.

Table 2: E-PASS component scores by anastomotic leakage status.

E-PASS score	With leak, (n=4)	Without leak, (n=56)	P value
PRS	0.990±0.111	0.325±0.341	<0.001
SSS	0.308±0.081	0.255±0.072	0.162 (NS)
CRS	0.899±0.041	0.213±0.278	<0.001

*NS-not significant.

Mean PRS and CRS were significantly higher in patients who developed leakage; SSS alone did not differ significantly between groups, indicating that preoperative physiological vulnerability, rather than the magnitude of intraoperative stress, was the dominant contributor to leakage risk in this cohort (Table 2).

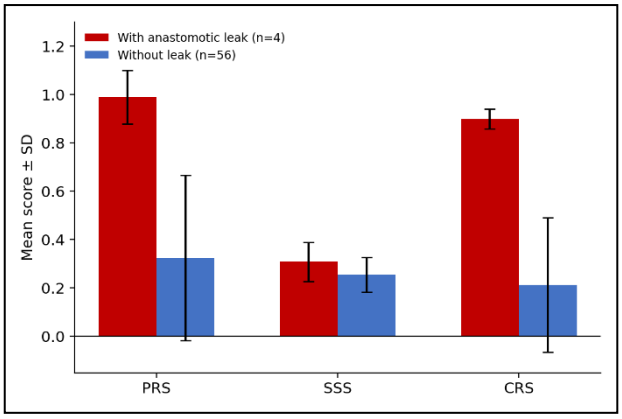


Figure 3: Comparison of mean E-PASS component scores (PRS, SSS, CRS±SD) between patients with and without anastomotic leakage.

Table 3: Anastomotic leakage rate by CRS category and diagnostic performance of CRS ≥0.9.

CRS category	N	With leak	Leak rate (%)
<0	14	0	0.0
0–0.5	32	0	0.0
0.5-0.9	11	1	9.1
≥0.9	3	3	100.0

A CRS threshold of ≥0.9 identified 3 of 4 leakage patients, all of whom leaked (positive predictive value 100%), while no false positives occurred; the fourth leak occurred at a CRS of 0.839, just below this threshold. Overall diagnostic performance of CRS ≥0.9 was: sensitivity 75.0%, specificity 100%, positive predictive value 100%, negative predictive value 98.2%. The single death in the cohort occurred in the patient with the highest CRS (1.118) and confirmed leakage; no death occurred in any patient without leakage.

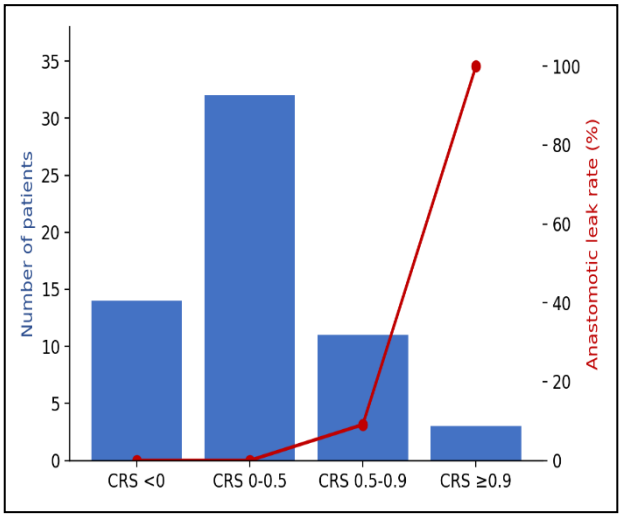


Figure 4: Distribution of patients by CRS category with corresponding anastomotic leakage rate, illustrating the sharp rise in leak rate at CRS ≥0.9.

DISCUSSION

In this prospective cohort from a large North Indian public teaching hospital, the E-PASS CRS discriminated well between patients who did and did not develop anastomotic leakage, with a CRS ≥0.9 achieving 100% specificity and 100% positive predictive value, at the cost of moderate sensitivity (75.0%). The overall leakage rate of 6.7% falls within the wide range reported across the literature (0.5-30%, typically 2-20% depending on anastomotic site) and is lower than the 15.6% reported in the RIMS Ranchi seed study on which our sample size was based, though the small number of events (n=4) in our cohort limits the precision of this comparison.[3,7]

Consistent with prior reports, we found that individual comorbidities-ischaemic heart disease, pulmonary disease and diabetes-were each significantly associated with leakage, mirroring findings by Kruschewski et al and Shinji et al for cardiac disease, and by Jina and Singh for diabetes and ASA grade in an Indian cohort.[8-10] A novel observation in our data was that leakage occurred only in patients with a combined burden of two or more major comorbidities, and never in patients with a single comorbidity in isolation, suggesting that cumulative physiological vulnerability-the underlying construct captured by the PRS-is a more relevant unit of risk than any individual diagnosis.

The relatively weak, non-significant contribution of the SSS in our cohort contrasts with reports emphasising operative duration and blood loss as independent predictors of leakage.[10,16] This may reflect the small number of leak events, the uniform use of laparotomy (removing incision-extent variability from the SSS), or a genuine population-specific pattern in which preoperative optimisation matters more than intraoperative technique at this centre. This finding, together with the fact that the CRS ≥0.9 threshold missed one leak (CRS 0.839), suggests the threshold should prompt heightened vigilance rather than be treated as a definitive rule-in/rule-out test, and that combined comorbidity burden is a useful complementary bedside marker.

The single mortality in our cohort occurred in the patient with both confirmed leakage and the highest CRS recorded (1.118), on postoperative day 7-within the expected window of peak anastomotic vulnerability (POD 3-6) described in the wound-healing literature.[12,17] This is consistent with the E-PASS model's premise that a high CRS identifies patients at combined risk of both anastomotic failure and death, though with only one death, this association cannot be tested statistically and should be regarded as descriptive.[18-20]

Our findings support incorporating E-PASS into intraoperative decision-making at high-volume Indian tertiary centres: a CRS approaching or exceeding 0.9, particularly in a patient with two or more major comorbidities, should prompt consideration of temporary faecal diversion rather than primary anastomosis, or at minimum, intensified postoperative surveillance from postoperative day 3 onward.

Limitations

This was a single-centre study with a modest sample size and only four leakage events and one death, which limits statistical power for subgroup analysis and widens the confidence intervals around our diagnostic performance estimates. All patients underwent conventional laparotomy, limiting variability in the SSS incision-extent parameter. Follow-up was restricted to 14 days, and later-presenting leaks may not have been captured. Variables not included in the E-PASS formula-serum albumin, haemoglobin, smoking status and anastomotic technique-could not be assessed as independent predictors and may confound the associations reported. Larger multicentre studies are needed to confirm the CRS≥0.9 threshold and refine it for maximal sensitivity without loss of specificity.

CONCLUSION

E-PASS, and specifically its CRS, is a practical, objective tool for stratifying anastomotic leakage risk after gastrointestinal surgery in a North Indian tertiary care setting. A CRS ≥0.9 was highly specific for leakage in this cohort, and leakage risk was driven predominantly by preoperative physiological vulnerability-particularly clustering of diabetes, cardiac and pulmonary disease-rather than intraoperative surgical stress. Preoperative optimisation of modifiable comorbidities and CRS-guided intraoperative decision-making merit prospective evaluation in larger, multicentre cohorts.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee S.M.S. Medical College and Attached Hospitals, Jaipur (Ref. MC/EC/2024)

REFERENCES

1. Bruce J, Krukowski ZH, Al-Khairy G. Systematic review of the definition and measurement of anastomotic leakage after gastrointestinal surgery. Br J Surg. 2001;88(9):1157-68.
2. Girard E, Messager M, Sauvanet A, Benoist S, Piessen G, Mabrut JY, et al. Anastomotic leakage after gastrointestinal surgery: diagnosis and management. J Visc Surg. 2014;151(6):441-50.
3. Makelä JT, Kiviniemi H, Laitinen S. Risk factors for anastomotic leakage after left-sided colorectal resection with rectal anastomosis. Dis Colon Rectum. 2003;46:653-60.
4. Kim SH, Son SY, Park YS, Sang-Hoon A, Do JP, Hyung-Ho K. Risk factors for anastomotic leakage: a retrospective cohort study in a single gastric surgical unit. J Gastric Cancer. 2015;15(3):167-75.

5. Nag DS, Dembla A, Mahanty PR, Kant S, Chatterjee A, Samaddar DP, et L. Comparative analysis of APACHE-II and P-POSSUM scoring systems in predicting postoperative mortality in patients undergoing emergency laparotomy. World J Clin Cases. 2019;7(16):2227–37.
6. Haga Y, Ikei S, Ogawa M. Estimation of Physiologic Ability and Surgical Stress (E-PASS) as a new prediction scoring system for postoperative morbidity and mortality following elective gastrointestinal surgery. Surg Today. 1999;29(3):219-25.
7. Kamal AK, Gaurav K, Toppo S, Pratap V, Zia A. Evaluation of Physiological Ability and Surgical Stress Scoring System (E-PASS) in prediction of anastomotic leakage in gastrointestinal operations in RIMS, Ranchi. Int J Acad Med Pharm. 2024;6(1):257-62.
8. Kruschewski M, Rieger H, Pohlen U, Hotz HG, Buhr HJ. Risk factors for clinical anastomotic leakage and postoperative mortality in elective surgery for rectal cancer. Int J Colorectal Dis. 2007;22(8):919-27.
9. Shinji S, Ueda Y, Yamada T, Koizumi M. Male sex and history of ischemic heart disease are major risk factors for anastomotic leakage after laparoscopic anterior resection in patients with rectal cancer. BMC Gastroenterol. 2018;18(1):117.
10. Jina A, Singh UC. Factors influencing intestinal anastomotic leakage and their predictive value. Int Surg J. 2019;6(12):4495-501.
11. Brem H, Tomic-Canic M. Cellular and molecular basis of wound healing in diabetes. J Clin Invest. 2007;117(5):1219-22.
12. Delamaire M, Maugendre D, Moreno M, Le Goff MC, Allannic H, Genetet B. Impaired leucocyte functions in diabetic patients. Diabet Med. 1997;14(1):29-34.
13. Haga Y, Wada Y, Takeuchi H, Koji I, Masakazu I, Osamu K. Evaluation of modified Estimation of Physiologic Ability and Surgical Stress in gastric carcinoma surgery. Gastric Cancer. 2012;15(1):7-14.
14. Komen N, Dijk JW, Lalmahomed Z, Karel K, Wim H, Gert-Jan K, et al. After-hours colorectal surgery: a risk factor for anastomotic leakage. Int J Colorectal Dis. 2009;24(7):789-95.
15. Chen G, Chen Y, Dai Y, Shi Z, Pan J, Fan X, et al. The Estimation of Physiologic Ability and Surgical Stress (E-PASS) model as a predictor of postoperative complications and mortality after digestive surgeries: a meta-analysis and systematic review. Ann Palliat Med. 2021;10(8):8672–83.
16. Kryzauskas M, Bausys A, Degutyte AE, Abeciunas V, Poskus E, Bausys R, et al. Risk factors for anastomotic leakage and its impact on long-term survival in left-sided colorectal cancer surgery. World J Surg Oncol. 2020;18:205.
17. Zhang A, Liu T, Zheng K, Liu N, Huang F, Li W, et al. Estimation of physiologic ability and surgical stress (E-PASS) scoring system could provide preoperative advice on whether to undergo laparoscopic surgery for colorectal cancer patients with a high physiological risk. Medicine (Baltimore). 2017;96(33):e7772.
18. Sharrock AE, Jenny McL, Robert C, Ian SB, James KB. Predictive value of lactate, ASA grade and P-POSSUM in emergency laparotomy patients aged over 70 years. World J Surg. 2017;41(2):402-9.
19. Quintel M, Pelosi P, Caironi P. An increase of abdominal pressure increases pulmonary edema in oleic acid induced lung injury. Am J Respir Crit Care Med. 2004;169(4):534-41.
20. Fielding LP, Stewart-Brown S, Blesovsky L, Kearney G. Anastomotic integrity after operations for large-bowel cancer: a multicentre study. Br Med J. 1980;281(6237):411-4.

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