Section: Surgery

Original Research Article

EVALUATION OF PHYSIOLOGICAL ABILITY AND SURGICAL STRESS SCORING SYSTEM (E-PASS) IN PREDICTION OF ANASTOMOTIC LEAKAGE IN GASTROINTESTINAL OPERATIONS IN RIMS, RANCHI

Anil Kumar Kamal[1], Kumar Gaurav[2], Samir Toppo[1], Vinay Pratap[3], Arquam Zia[4]

[1]Associate Professor, Department of Surgery, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India
[2]Assistant Professor, Department of Surgery, Rajendra Institute of Medical Sciences, Ranchi, Ranchi, Jharkhand, India
[3]Professor, Department of Surgery, Rajendra Institute of Medical Sciences, Ranchi, Ranchi, Jharkhand, India
[4]Junior Resident, Department of Surgery, Rajendra Institute of Medical Sciences, Ranchi, Ranchi, Jharkhand, India

Received : 21/11/2023
Received in revised form : 27/12/2023
Accepted : 12/01/2024

Keywords:
Anastomotic leakage (AL), E-PASS, elective, emergency, gastrointestinal.

Corresponding Author:
Dr. Samir Toppo,
Email: samirvtoppo06@gmail.com

DOI: 10.47009/jamp.2024.6.1.51

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (1); 257-262

Abstract

Background: The aim is to identify and predict risk factors for postoperative gastrointestinal anastomotic leakage & to study the anastomotic leakage postoperatively, morbidity and mortality associated with gastrointestinal anastomosis. **Materials and Methods:** Prospectively investigated for all 9 parameters of E-PASS, absence or presence of anastomotic leakage & mortality in 100 patients of age 18 years & above who underwent elective or emergency abdominal surgeries involving anastomosis of bowel but excluding patients who underwent a stoma procedure initially and having relaparotomy for reversal of stoma in a tertiary hospital, RIMS, Ranchi from 20th October 2021 and 19th October 2022. **Result:** Out of 100 patients included in the study, 65 were operated in emergency while 35 patients underwent elective procedure. Anastomotic leakage incidence was 14.29% in elective cases while 16.92% in emergency procedure. The mean value of Comprehensive Risk Score (CRS) with anastomotic leakage patients was 0.95 which was significantly higher than the patients without anastomotic leakage i.e. 0.50 ($p<0.0001$). **Conclusion:** The E-PASS scoring system which requires 6 pre-operative & 3 intra-operative parameters may be useful in predicting anastomotic leakage, its prognosis & hence deciding intraoperatively whether to undergo bowel anastomosis or alternative procedures.

INTRODUCTION

In elective and emergency settings, intestinal anastomoses are common major surgical procedures. The parameters in relation to the nature of disease, operating technique and host factors are important in defining the outcome and prognosis of intestinal anastomosis. Patients with anastomotic leaks have longer duration of stay, higher mortality rates, more readmission rates, more number of reoperations, and an overall greater impact on quality of life.[1] Unsurprisingly the incidence of leakage varies in the literature in a dramatic way.[2] According to the site of anastomosis, the prevalence and consequences of AL varies. The incidence ranges from 2.7% to 15% in esophageal anastomosis. It ranges between 5% to 20% in colorectal anastomosis. In pancreatico-enteric it occurs between 20% and 25% of all pancreatoduodenectomies.[3] The morbidity & mortality in anastomotic leaks almost doubles the hospital stay.[4]

There are multiple scoring systems available for the prediction of postoperative anastomotic leakage in a patient. According to Haga Y et al (1999) E-PASS scoring system is more accurate in evaluating elective enteric surgeries than any other existing system.[5] Again Haga Y et al (2012) validated E-PASS Scoring System in predicting anastomotic leaks and renamed it as mE-PASS.[6] Thus a surgeon, using this scoring system during operation, can be helpful in predicting anastomotic leakage in gastrointestinal anastomosis.

E-PASS scoring system has three components like Pre-operative risk score (PRS), Surgical Stress Score (SSS) and Comprehensive Risk Score (CRS). PRS provides an average estimate of change of clinical condition of the patient which would lead to the

ISSN (O): 2687-5365; ISSN (P): 2753-6556

postoperative complications. SSS quantifies the stress applied to the patient's homeostasis during surgery using type of incision, duration of operation and amount of loss of blood. Combining PRS and SSS scores gives CRS, which is an absolute number to the amount of 'operative stresses' undergone by the patient and his preoperative clinical condition.

Parameters for Preoperative Risk Score (PRS)[5]:

- Age in years
- Presence or absence of severe heart disease (NYHA class III or IV)
- Presence or absence of pulmonary disease (defined as vital capacity less than 60%)
- Diabetes Mellitus
- Performance Status Index (described by Japanese Cancer Society)
- ASA score

Parameters for Surgical Stress score (SSS):

- Approximate blood loss (ml/kg)
- Operating time (in hours)
- Extent of skin incision: three scores (0-minor incision, 1-laparotomy, 2-laparotomy with thoracotomy)

Equations: Pre-operative Risk Score = -0.0686 + 0.00345(X1) + 0.323(X2) +0.205(X3) + 0.153(X4) + 0.148(X5) + 0.0666(X6).

Factors used to calculate PRS are,

X1: age

X2: presence (1) or absence (0) of severe heart disease*,

X3: presence (1) or absence (0) of severe pulmonary disease*,

X4: presence (1) or absence (0) of diabetes mellitus,

X5: performance status index (0-4),

X6: American Society of Anaesthesiologists physiological status classification (1-5)

Surgical Stress Score = -0.342 + 0.0139(X1) + 0.0392(X2) +0.352(X3)

X1: blood loss/ body weight (g/kg),

X2: operation time (hours)

X3: extent of skin incision (0= minor incision for laparoscopic or thoracoscopic surgery, including scope-assisted surgery; 1= laparotomy or thoracotomy alone; 2= both laparotomy and thoracotomy)

Comprehensive Risk Score = -0.328 + 0.936 (PRS) + 0.976 (SSS)

*Severe heart disease: heart failure > New York Heart Association class 3, severe arrhythmia

*Severe pulmonary disease: %Vital Capacity < 60% or FEV1% < 50%

Aims and Objectives

- To identify and predict risk factors for post-operative gastrointestinal anastomotic leakage.
- To prevent the anastomotic leakage postoperatively, morbidity and mortality associated with gastrointestinal anastomosis.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of General Surgery, Rajendra Institute of Medical Sciences, Ranchi from October 2021 to October 2022. Prior approval was obtained from Institutional Ethical Committee, RIMS, Ranchi. Patient's written informed consent was obtained prior to the study. The formula n= Z2pq/d2 was used to calculate the sample size, where Z= standard normal deviate (for 95% CI, the value is taken as 1.96), p= prevalence, q= 100-p, d= precision (0.05). Patients included were those aged 18 years or above who underwent abdominal surgeries involving anastomosis of bowel either as elective or emergency procedure. Exclusion criteria include all patients who underwent stoma procedure and having relaparotomy for stoma reversal.

RESULTS

Out of 100 patients included in this study, 65 were operated in emergency while 35 patients underwent elective procedure. Among 100 cases, 16 cases had postoperative leakage. Anastomotic leakage incidence was 14.29% in elective cases while 16.92% in emergency procedure. Among 10 patients with heart disease, 7 patients with pulmonary disease and 26 patients with diabetes, 6, 3 & 8 had anastomotic leakage postoperatively respectively which was about 60%, 42% & 30% respectively.

On chi-square tests, heart disease was more significantly associated with the incidence of anastomotic leakage with p-value of <0.001 than diabetes and pulmonary disease whose p-values were 0.0169 and 0.044 respectively.

Mean operating time for patients with & without anastomotic leakage were 2.73 hours & 2.27 hours respectively. Among patients with & without anastomotic leakage the mean duration of hospital stay were 35 and 24.82 days respectively. Total number of deaths was 8. Death among patients with & without anastomotic leakage were 6 (37.5%) & 2 (2.38%) respectively.

Relevance of E-PASS scoring system in relation to incidence of anastomotic leakage:

Three components of E-PASS scoring system namely Pre-operative Risk Score (PRS), Surgical Stress Score (SSS) and Comprehensive Risk Score (CRS) for each patient were calculated. Mean value of each score among patients with and without anastomotic leakage were calculated and their significance was tested using t-test for equality of mean.

The mean Pre-operative Risk Score for patients with anastomotic leakage was 1.06±0.27 which was significantly higher than the patients without anastomotic leakage with mean Pre-operative Risk Score 0.66±0.18. The t-test for equality of means was significant (p<0.0001). The mean Surgical Stress Score for patients with anastomotic leakage was 0.29±0.08 which was significantly higher than the

ISSN (O): 2687-5365; ISSN (P): 2753-6556

patients without anastomotic leakage with mean Surgical Stress Score 0.21±0.07. The t-test for equality of means was calculated and was significant (p<0.0001). Similarly the mean Comprehensive Risk Score for patients with anastomotic leakage was 0.95±0.20 which was significantly higher than the patients without anastomotic leakage with mean Comprehensive Risk Score 0.50±0.17. The t-test for equality of means calculated and was significant (p<0.0001).

Table 1: Age Distribution

Age group (years)	Frequency (n)	Percent (%)
18–30	14	14
31–40	32	32
41–50	29	29
51–60	16	16
61–70	7	7
71 & above	2	2
Total	100	100

Mean age is 43.36 years.

Table 2: Case Distribution

Diagnosis	Frequency (n)	Percent (%)
Acute Intestinal Obstruction (Koch's abdomen)	8	8
Adhesive Intestinal Obstruction	10	10
Blunt Trauma Abdomen	16	16
CBD injury	5	5
Caecal volvulus	1	1
Carcinoma Ascending Colon	1	1
Carcinoma Stomach	17	17
Carcinoma descending colon	2	2
Choledochal Cyst type 1	1	1
Distal CBD stricture	2	2
GOO- Caustic Ingestion	2	2
GOO- Chronic duodenal ulcer	1	1
GOO- GIST	2	2
Ileal Gangrene- Mesenteric Ischemia	5	5
Ileocaecal tuberculosis	1	1
Multiple Ileal Perforation	1	1
Periampullary Carcinoma	2	2
Sigmoid Volvulus	9	9
Strangulated Femoral Hernia	4	4
Strangulated Incisional Hernia	6	6
Strangulated Inguinal Hernia	4	4
Total	100	100

Table 3: Incidence of co-morbidities in study population (n=100)

Co-morbidities	No. of patients	No. of patients with AL (%)
Heart disease	10	6 (60%)
Pulmonary disease	7	3 (42%)
Diabetes mellitus	26	8 (30%)

Table 4: t-test tables for Mortality Risk Prediction

PRS	**Mortality**	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	**p value**
	No	92	0.7142984	0.0237294	0.6671628± 0.761434	0.04
	Yes	8	0.8886	0.1025439	0.6461223± 1.131078	
SSS	**Mortality**	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	**p value**
	No	92	0.2192391	0.0073514	0.070512±0.2046365	0.001
	Yes	8	0.33125	0.0335643	0.0949342±0.251883	
CRS	**Mortality**	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	**p value**
	No	92	0.5545607	0.2249615	0.5079725± 0.6011489	0.001
	Yes	8	0.8270296	0.2774861	0.5950454± 1.059014	

Table 5: Mean CRS and Anastomotic leakage

CRS	Mean	S.D.	p Value
Leakage	0.95	0.20	<0.0001
No leakage	0.50	0.17	

Comparison of patients with CRS >0.9 and CRS <0.9: CRS were compared between patients with leakage and those without leakage. CRS >0.9 was associated significantly with the anastomotic leakage (p<0.0001). The mean value of CRS for patients with anastomotic leakage was significantly higher than in patients without leakage. The t-test for equality of means was significant (p<0.0001).

ISSN (O): 2687-5365; ISSN (P): 2753-6556

DISCUSSION

Surgeons usually encounter postoperative anastomotic leakage as a common complication in gastrointestinal surgeries. Several studies have identified multiple risk factors for anastomotic leakage such as amount of blood loss, male sex, excessive smoking, ASA score, low preoperative serum albumin, long duration of operation, IHD, diabetes mellitus and pulmonary diseases. There are only few studies reported to predict the actual incidence of anastomotic leakage, therefore this study was undertaken to predict the anastomotic leakage using E-PASS scoring system which is based on the hypothesis that patients' homeostasis is deranged when the physiological reserve is overtaken by surgical stress.

In this present study, majority of the patients (n=61) belongs to 31-50 years of age group. Maximum number of patients (n=5) were in age group 61-70 years in which anastomotic leakage was encountered. Abhishek Jina (2019) in their study reported maximum number of anastomotic leaks in the 51-60 yrs age group (23.07%).[4]

In our study, incidence of anastomotic leakage was 15.61%. Abhishek Jina (2019) reported anastomotic leakage in 16.02% cases.[4] Seiichi Shinji et al,[9] (2018) also reported that overall rate of anastomotic leakage was 11.7% (18 out of 154 patients).

In majority of cases (18%) the cause of resection & anastomosis was due to intestinal obstruction, however it was in 15% cases reported by Abhishek Jina (2019).[4] In their series leakage rate was highest in patients (36.36%) with sigmoid volvulus with obstruction.

It was observed that incidence of anastomotic leakage was more (16.2%) in emergency cases than in elective operations (14.29%). Results of our study are in accordance with the study of Abhishek Jina,[4] (2019) who reported higher incidence of leakage in cases in which emergency surgery was done (17.59%). Many studies reported that the cases who underwent emergency operations, there was increased incidence of anastomotic leakage. This is due to many factors like poor general condition, decreased oxygen transport to the anastomotic site due to hypoxemia, anaemia, faecal contamination of gut and loaded bowel. Though conflicts are present wherein elective cases, regarding bowel preparation in emergency cases there is high proliferation of bacteria and sepsis which affects anastomotic healing.[7,8]

Three important co-morbid conditions such as IHD, diabetes mellitus and pulmonary disease were evaluated in E-PASS scoring system. The effect of each co-morbid condition was also studied on the incidence of anastomotic leakage. Association of co-morbid conditions with anastomotic leakage were tested using chi-square test, of which heart disease (p value 0.001) was more strongly associated with the leakage than pulmonary disease (p 0.044) or diabetes (p 0.0169). Seiichi Shinji et al,[9] (2018) found that a history of IHD (ischemic heart disease) was strongly related with anastomotic leakage (p=0.012).

Ischaemic heart disease was associated with anastomotic leakage and can be explained by the impairment of the microvascular blood supply at anastomotic site, however how a history of heart disease affects anastomotic leakage is not clear. Kruschewski et al,[10] (2007) reported that ischaemic heart disease is a risk factor for anastomotic leakage. They reported that the serosal microvascular disease at anastomosis leads to impaired microcirculation which decreases flow of blood and impaired wound healing resulting in anastomotic leakage. Ischaemic heart disease is associated with arteriosclerosis. Their findings suggest that patients with a history of ischaemic heart disease already have intestinal microvascular disease, which results in impaired circulation at anastomotic sites. In cases with mesenteric ischemia, the viability of gut ends must be assessed intraoperatively. If gut ends are not viable then some studies suggest making both ends of gut as an ostomy and later re-laparotomy can be performed for anastomosis when general condition of patient improves.

Anastomotic leakage is significantly associated with severe pulmonary disease which could be due to ischemia. In extensive abdominal tuberculosis cases there was impaired wound healing which leads to anastomotic leakage. Severe pulmonary disease has significant association with anastomotic leakage which could be due to derangement of pulmonary function in emergency cases with high abdominal compartment pressure. Michael Quintel et al,[11] (2004) reported the hazardous effects of high abdominal compartment pressure in the pulmonary system particularly in prior lung injury. In acute abdomen patients in postoperative period, to improve the pulmonary function, resuscitation and preoperative management could improve peri-ananstomotic oxygen tension and prevent anastomotic leakage. In emergency setting diversion operation could be done in patients with severely deranged pulmonary function and definitive anastomosis could be done later when the pulmonary function improves.

As an important preoperative parameter, probably DM causes ischemia of the substituted conduit induced by destroyed vascular system which impairs the anastomotic healing and cause an AL.[12,13]

In our study, another factor was mean operating time which was 2.73 hours for patients with anastomotic leakage and it was more than the patient without a leakage (2.27 hours). Some studied reported that the duration of anesthesia can increase the morbidity postoperatively while the effect of duration of operating time on incidence of anastomotic leakage is not well reported. Komen N et al,[14] (2009) in his series of 739 patients who underwent colorectal analysis stated that overall, the median duration of anesthesia was 217 min (range 75–630 min) and the

ISSN (O): 2687-5365; ISSN (P): 2753-6556

median duration of operation was 162 min (range 49–497 min).

One of the parameters like duration of hospital stay is used statistically to measure the morbidity associated with diseases. In our study, mean duration of stay in the hospital for patients with anastomotic leakage was 35 days and that of without leakage was 24.82 days. Therefore anastomotic leaks increase the duration of hospital stay which ultimately increases the morbidity associated with the surgical operations. Abhishek Jina,[4] (2019) has also shown about three-fold higher hospital stay and increased morbidity in patients suffering from anastomotic leakage.

Among 16 patients with anastomotic leakage, 6 patients (37.5%) died postoperatively. Mortality was around 2.38% in patients without anastomotic leakage. Thus anastomotic leakage increases the morbidity and mortality postoperatively. The mortality rate for an anastomotic leakage in the literature typically is in the range of 10% to 15%.[15-18]

Fielding LP et al,[19] (1980) stated that, despite the "perfect patient", healthy bowel and good technique, some anastomoses continue to leak resulting in significant morbidity and mortality (e.g., 22% mortality in patients with a leakage vs 7.2% mortality in those without leakage).

Analysis of E-PASS scoring system

In our study, each score in E-PASS scoring system was associated with the incidence of postoperative anastomotic leakage significantly. Postoperative anastomotic leakage was 100% associated with Comprehensive Risk Score >1.0. Nearly 78.57% of patients who had anastomotic leakage had Comprehensive Risk Score >0.9. Computation of preoperative risk score needs only six parameters viz. age, presence of co-morbid conditions like ischaemic heart disease, diabetes mellitus, pulmonary disease, ASA score and performance index score. These parameters can be easily available preoperatively. For computation of Surgical Stress Score, three parameters are needed like expected blood loss, approximate operating time, and extent of skin incision. Operating surgeon can also judge preoperatively these factors with reasonable accuracy.

Comprehensive Risk Score of > 0.9 was associated with incidence of postoperative anastomotic leakage significantly (p= <0.0001). With nine parameters available, E-PASS scores can be computed before surgery easily. If the Comprehensive Risk Score is >0.9, in emergency setting, a surgeon can decide ostomy operation and do the definitive anastomosis later on when clinical status of patient improves.

In this study, the mean value of CRS was 0.827 in patient who died postoperatively and was 0.554 for alive patients. Thus mortality rate correlates well with increasing value of CRS.

CONCLUSION

The E-PASS scoring system is a useful predictor of post-operative morbidity and mortality. E-PASS scoring system can be applied to predict anastomotic leakage which is a dreadful complication following bowel anastomosis in emergency as well as elective surgeries. A CRS value below 0.9 can be considered unsafe for undergoing primary bowel anastomosis and hence an alternative procedure can be employed & definitive surgery could be done at later stage once the physiological status of the patient optimizes. This can immensely help in decreasing the morbidity & mortality following bowel anastomosis.

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 Color Dis. 2007;22(8):919–27.

Acknowledgement: The authors are sincerely thankful to Departmental Research Committee, the faculty and staff of the Department of Surgery, RIMS, Ranchi for their support in completing the study.

REFERENCES

1. Richards CH, Campbell V, Ho C, Hayes J, Elliott T, Thompson-Fawcett M. Smoking is a major risk factor for anastomotic leakage in patients undergoing low anterior resection. Colorectal Dis. 2012;14(5):628–633.
2. Bruce J, Krukowski ZH, Al-Khairy G. Systematic review of the definition and measurement of anastomotic leakage after gastrointestinal surgery. Br J Surg. 2001;88:1157–1168.
3. Panel E. Girard, Messager M, Sauvanet A, Benoist S, Piessen G, Mabrut J, Mariette C. Anastomotic leakage after gastrointestinal surgery: Diagnosis and management. Journal of Visceral Surgery. 2014; 151(6):441-450.
4. Abhishek Jina, Umesh Chandra Singh. Factors influencing intestinal anastomotic leakage and their predictive value. Int Surg J. 2019 Dec;6(12):4495-4501.
5. 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.
6. Yoshio Haga, Yasuo Wada, Hitoshi Takeuchi, Koji Ikejiri, Masakazu Ikenaga & Osamu Kimura. Evaluation of modified Estimation of Physiologic Ability and Surgical Stress in gastric carcinoma surgery. Gastric Cancer 2012;15:7–14.
7. Kim SH, Son SY, Park YS, Ahn SH, Park DJ, Kim HH. Risk Factors for Anastomotic Leakage: A Retrospective Cohort Study in a Single Gastric Surgical Unit. J Gastric Cancer. 2015;15:167-75.
8. Mäkelä 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.
9. Seiichi Shinji, Yoshibumi Ueda, Takeshi Yamada, Michihiro Koizumi, Yasuyuki Yokoyama, Goro Takahashi, Masahiro Hotta, Takuma Iwai, Keisuke Hara, Kohki Takeda, Mikihiro Okusa, Hayato Kan, Eiji Uchida, Hiroshi Yoshida. .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 Jul 17;18(1):117.
10. 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 Color Dis. 2007;22(8):919–927.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

11. Michael Quintel, Paolo Pelosi, Pietro Caironi, Jurgen Peter Meinhardt, Thomas Luecke, Peter Herrmann. An increase of abdominal pressure increases pulmonary edema in oleic acid induced lung injury. ATS Journal. Feb 2004;169(4).
12. Brem H, Tomic-Canic M. Cellular and molecular basis of wound healing in diabetes. J Clin Invest. 2007;117(5):1219–1222.
13. 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.
14. Komen, N, Dijk, JW, Lalmahomed, Z. After-hours colorectal surgery: a risk factor for anastomotic leakage. Int J Colorectal Dis. 2009;24:789–795.
15. Docherty JG, McGregor JR, Akyol AM. Comparison of manually constructed and stapled anastomoses in colorectal surgery: West of Scotland and Highland Anastomosis Study Group. Ann Surg. 1995;221: 176–184.
16. Fingerhut A, Elhadad A, Hay JM. Infraperitoneal colorectal anastomosis: hand-sewn versus circular staples. A controlled clinical trial: French Associations for Surgical Research. Surgery. 1994;116: 484–490.
17. Fingerhut A, Hay JM, Elhadad A. Supraperitoneal colorectal anastomosis: hand-sewn versus circular staples. A controlled clinical trial: French Associations for Surgical Research. Surgery. 1995;118:479–485.
18. Bokey EL, Chapuis PH, Fung C. Postoperative morbidity and mortality following resection of the colon and rectum for cancer. Dis Colon Rectum. 1995;38:480–487.
19. 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: 411-41.
20. 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 Color Dis. 2007;22(8):919–27.
21. Vignali A, Gianotti L, Braga M, Radaelli G, Malvezzi L, Di 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 Color Dis. 2007;22(8):919–27.
22. Vignali A, Gianotti L, Braga M, Radaelli G, Malvezzi L, Di 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 Color Dis. 2007;22(8):919–27.
23. Vignali A, Gianotti L, Braga M, Radaelli G, Malvezzi L, Di 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 Color Dis. 2007;22(8):919–27.

ISSN (O): 2687-5365; ISSN (P): 2753-6556