

FREQUENCY OF ANASTOMOTIC LEAKAGE IN PRIMARY REPAIR OF
ACUTE COLONIC INJURYSahibzada Saad Ur Rehman¹, Atta Ullah Arif^{*2}, Naveed Ahmad³, Farhan Aslam⁴,
Muhammad Daud⁵, Hazrat Abu Bakar Burki⁶^{*1,2,3,4,5,6} General Surgery Department, Lady Reading Hospital, Peshawar, Khyber Pakhtunkhwa, Pakistan.^{*1}attaullah.arif@lrh.edu.pkDOI: <https://doi.org/10.5281/zenodo.15737520>**Keywords**Anastomotic Leak; Colorectal
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Abstract**Background:** Anastomotic leakage remains a significant complication following primary repair of acute colonic injuries. Local data on leakage rates following primary colonic repair in trauma settings is limited, necessitating investigation to inform clinical practice.**Objective:** To determine the frequency of anastomotic leakage following primary repair of acute colonic injury and identify associated risk factors.**Methods:** A prospective descriptive study was conducted 5th December 2024 to 5th June 2025 at Lady Reading Hospital. A total of 142 patients aged 18-70 years with acute colonic injury were enrolled using consecutive sampling. Patients with prior abdominal surgery, morbid obesity, pregnancy, or chronic diseases were excluded. All patients underwent primary repair with standardized techniques. Postoperative monitoring for anastomotic leakage was conducted for 15 days using clinical assessment and CT imaging.**Results:** Overall anastomotic leakage frequency was 23.9% (34/142 patients; 95% CI: 17.2-31.7%). Mean age was 42.3 ± 14.7 years with 69.0% males. Blunt trauma was most common (47.2%), followed by firearm injury (30.3%) and stab wounds (22.5%). Penetrating trauma showed significantly higher leakage rates than blunt trauma (29.3% vs 17.9%, $p = 0.042$). Associated injuries significantly increased leakage rates (29.5% vs 17.2%, $p = 0.031$). Leakage was associated with prolonged hospitalization (median 19 vs 8 days, $p < 0.001$), higher reoperation rates (47.1% vs 1.9%, $p < 0.001$), and increased mortality (11.8% vs 1.9%, $p = 0.018$).**Conclusion:** Anastomotic leakage occurs in nearly one-quarter of patients, with penetrating trauma and associated injuries as significant risk factors, emphasizing the importance of careful patient selection and vigilant monitoring.**INTRODUCTION**

In the last 30 years, management of colon injuries has evolved. Prior to that, a considerable number of these colonic injuries among the population were managed with either proximal colostomy or exteriorization of the affected region because of concerns over a heightened risk of dehiscence. A

discernible trend towards primary repair has emerged over the past two decades.¹ The advantages of primary repair include avoidance of colostomy, consequent reduction in morbidity, costs associated with colostomy aftercare, and final hospitalization for closure. The mortality and morbidity rates

associated with repair failure are potential drawbacks of primary repair.²

Despite an advanced surgeon's significantly higher success rate in performing intestinal anastomosis than surgeons from a previous generation, the outcomes have not consistently been impeccable.³ Research indicates that performing delayed anastomosis (DA) in individuals undergoing damage-control laparotomy (DCL) for severe colonic injuries is both safe and feasible. Concerns persist regarding the identification of individuals at elevated risk and the mitigation of anastomosis-related complications, despite the demonstrated viability of primary colonic anastomosis in trauma patients. Furthermore, approximately 13% of patients with an initial anastomosis had an anastomotic leak.⁴

The surgical methods employed to address colonic injury are largely acknowledged to not influence the outcome. However, there are distinct dangers of concern. Ongoing research is aimed at elucidating these ambiguous risk factors. Traumatic colon injuries are difficult to manage and associated with significant morbidity. The concluding segment of the digestive system and gastrointestinal tract in vertebrates is the large intestine, sometimes referred to as the colon or the large bowel. The leftover waste is initially received as liquid and is eventually retained as feces before elimination.^{5,6}

The anal canal, which commonly encompasses the colon, cecum, and rectum, is not universally recognized in all authors' definitions of the large intestine. The commencement of the large intestine was situated in the right iliac region of the pelvis, directly beneath the waist. The ileocecal valve links the large intestine with the faeces.^{7,8} A study reported the frequency of anastomotic leakage in primary repair of acute colonic injury was 23.6%.⁹ The complexity of colonic trauma management is further compounded by the high incidence of associated intra-abdominal injuries, with studies showing that approximately 70% of patients with colonic injuries have concomitant organ damage, significantly contributing to increased operative complexity and elevated morbidity and mortality rates.¹⁰

Anastomotic leakage can lead to serious consequences, including sepsis, increased morbidity, and prolonged hospital stays, which not only impact individual patients, but also strain healthcare

resources. No such data are available on this subject locally; therefore, the goal of this study was to determine the frequency of anastomotic leakage in the primary repair of acute colonic injury and associated risk factors in our health setting. As advancements in surgical techniques and perioperative care have evolved, there is a critical need to evaluate factors contributing to leakage, such as surgical skill, tissue viability, and patient-related variables. By systematically investigating these elements, we can better understand the mechanisms underlying leakage and develop targeted strategies to reduce its occurrence. This research aimed to provide valuable insights to health professionals that could inform clinical practices, enhance surgical protocols, and ultimately improve patient safety and recovery in the management of acute colonic injuries.

METHODOLOGY

This prospective descriptive study was conducted in the General Surgery Department of Lady Reading Hospital from 5th December 2024 to 5th June 2025 after Ethical approval with Ref: No. 449/LRH/ MTI obtained from the Institutional Ethical Review Board of Lady Reading Hospital, Peshawar, as well as proposal approval from the research evaluation unit of the College of Physicians and Surgeons Pakistan (CPSP). A total of 142 patients were enrolled using consecutive non-probability sampling. The sample size was calculated using the WHO sample size calculator based on an expected frequency of 23.6%, margin of error of 7%, and 95% confidence level. Patients aged 18–70 years of either sex who presented with acute colonic injury, which was defined as free air, hematoma, or contrast extravasation observed on CT scan in patients presenting with symptoms such as abdominal pain (VAS >3), distension, tenderness, and changes in bowel habits, were included. Patients with a history of abdominal surgery, morbid obesity, pregnancy, or chronic liver or renal disease were excluded. After confirming eligibility, each patient was informed of the purpose, benefits, and potential risks of the study. Written informed consent was obtained from all participants prior to inclusion in the study.

Demographic and baseline data including age, sex, BMI, socioeconomic status, area of residence, education level, and employment status were

recorded. All included patients underwent surgical management of acute colonic injury under general anesthesia. A standard abdominal incision was made to access the colon, and the site and extent of injury were assessed. Any devitalized or necrotic tissue surrounding the injury was debrided to ensure viable margins for repair. The adjacent bowel segments were mobilized to allow tension-free anastomosis. Repair was performed using either interrupted or continuous sutures, depending on the intraoperative findings.

The patients were monitored postoperatively for 15 days to detect any signs of anastomotic leakage. Leakage was defined as the presence of fluid collections around the anastomosis observed on CT scan in patients presenting with all symptoms, such as fever (Body Temperature > 38.5 °C), tenderness, guarding, and abdominal distension. All procedures and assessments were performed or supervised by consultants with at least five years of post-fellowship experience. The data were documented using a predesigned structured proforma.

Statistical analyses were conducted using IBM SPSS version 25. The distribution of numerical variables, such as age, BMI, and postoperative hospital stay, was assessed using the Shapiro-Wilk test. These variables were presented as mean \pm standard deviation or median with interquartile range, as appropriate. Categorical variables, including sex, anastomotic leakage, associated injuries (e.g., liver laceration, splenic injury, and multiple rib fractures), type of trauma (firearm injury, blunt trauma, or stab wound), socioeconomic status, area of residence, education, and employment status were reported as frequencies and percentages. Effect modifiers were controlled through stratification, and post-stratification associations were analyzed using the chi-square test or Fisher's exact test, where appropriate. Statistical significance was set at $P < 0.05$.

RESULTS

A total of 142 patients with acute colonic injuries who underwent primary repair were included in this study. The demographic characteristics showed a mean age of 42.3 ± 14.7 years (range: 18-70 years), with male predominance accounting for 98 patients (69.0%) and females comprising 44 patients (31.0%). The mean BMI was 24.8 ± 3.2 kg/m² across the

study population. Analysis of the mechanism of injury revealed that blunt trauma was the most common cause, affecting 67 patients (47.2%), followed by firearm injury in 43 patients (30.3%), and stab wounds in 32 patients (22.5%). Associated injuries were documented in 78 patients (54.9%), while 64 (45.1%) had isolated colonic injuries.

The primary outcome of this study was the frequency of anastomotic leakage following primary repair of acute colonic injury. Of the 142 patients who underwent primary repair, 34 developed anastomotic leakage within the 15-day postoperative monitoring period, yielding an overall frequency of 23.9% with a 95% confidence interval of 17.2-31.7%. This finding aligns closely with the expected frequency of 23.6% reported in the literature, which forms the basis for our sample size calculation. The Shapiro-Wilk test for normality assessment demonstrated that age was normally distributed ($W = 0.982$, $p = 0.089$), whereas BMI and hospital stay duration were non-normally distributed ($p < 0.05$), necessitating the use of appropriate non-parametric statistical tests for these variables.

Risk factor analysis revealed significant associations between certain patient and injury characteristics and development of anastomotic leakage. Patients who sustained penetrating trauma (combined firearm injuries and stab wounds) demonstrated a significantly higher rate of anastomotic leakage (29.3%) than those with blunt trauma (17.9%) ($p = 0.042$). Similarly, the presence of associated injuries was significantly associated with increased leakage rates, with 29.5% of patients with associated injuries developing leakage compared with 17.2% of those with isolated colonic injuries ($p = 0.031$). Age stratification showed that patients older than 45 years had a higher leakage rate of 29.1% compared with 20.7% in younger patients, although this difference was not statistically significant ($p = 0.234$). Gender analysis revealed that males had a slightly higher leakage rate (26.5%) than females (18.2%), but this difference was not statistically significant ($p = 0.187$). Patients with BMI ≥ 25 kg/m² showed a higher tendency toward anastomotic leakage at 28.1% compared to those with a normal BMI of 20.5%, although this association approached but did not achieve statistical significance ($p = 0.089$).

Clinical outcome analysis demonstrated significant differences between patients who developed anastomotic leakage and those who did not. The hospital stay duration was significantly prolonged in patients with anastomotic leakage, with a median stay of 19 days (IQR: 14-26) compared to 8 days (IQR: 6-12) in patients without leakage ($p < 0.001$). The need for reoperation was dramatically higher in the leakage group, with 16 of 34 patients (47.1%) requiring surgical reintervention compared to only 2 of 108 patients (1.9%) in the non-leakage group ($p <$

0.001). The overall mortality in the study was 6 patients (4.2%), with a significantly higher mortality rate observed in patients who developed anastomotic leakage at 11.8% (4 out of 34 patients) compared to 1.9% (2 out of 108 patients) in those without leakage ($p = 0.018$). All statistical analyses were performed using IBM SPSS version 25.0, with categorical variables analyzed using the Chi-square test or Fisher's exact test, as appropriate, and a p-value of less than 0.05 considered statistically significant.

Table 1: Baseline Characteristics and Clinical Outcomes (n=142)

Variable	Category/Outcome	Frequency (n)	Percentage (%)
Demographics	Age (years) - Mean \pm SD	42.3 \pm 14.7	-
	Gender - Male	98	69.0
	Gender - Female	44	31.0
Trauma Type	BMI (kg/m ²) - Mean \pm SD	24.8 \pm 3.2	-
	Blunt Trauma	67	47.2
	Firearm Injury	43	30.3
	Stab Wound	32	22.5
Associated Injuries	Present	78	54.9
	Absent	64	45.1
Primary Outcome	Anastomotic Leakage - Present	34	23.9
	Anastomotic Leakage - Absent	108	76.1
Secondary Outcomes	Hospital Stay (days) - Median (IQR)	10 (7-15)	-
	Reoperation Required - Yes	18	12.7
	Mortality - Yes	6	4.2

SD = Standard Deviation; BMI = Body Mass Index; IQR = Interquartile Range. Data presented as mean \pm standard deviation for continuous variables and frequency (percentage) for categorical variables. Hospital stay presented as median (IQR) due to non-normal distribution.

Table 2: Risk Factor Analysis for Anastomotic Leakage

Risk Factor	Category	Leakage Present n(%)	Leakage Absent n(%)	p-value*
Age Group	≤ 45 years	18 (20.7)	69 (79.3)	0.234
	> 45 years	16 (29.1)	39 (70.9)	
Gender	Male	26 (26.5)	72 (73.5)	0.187
	Female	8 (18.2)	36 (81.8)	
Trauma Type	Blunt	12 (17.9)	55 (82.1)	0.042
	Penetrating	22 (29.3)	53 (70.7)	
Associated Injuries	Present	23 (29.5)	55 (70.5)	0.031
	Absent	11 (17.2)	53 (82.8)	
BMI	Normal (< 25)	16 (20.5)	62 (79.5)	0.089
	Overweight/Obese (≥ 25)	18 (28.1)	46 (71.9)	

Chi-square test or Fisher's exact test as appropriate. Bold values indicate statistical significance ($p < 0.05$).

Error bars represent 95% confidence intervals. Chi-square test, $p = 0.042$ (Significant).

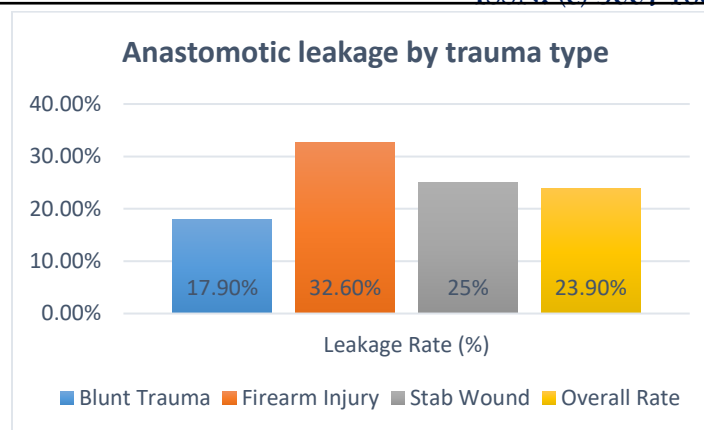


Figure 1: Frequency of Anastomotic Leakage by Trauma Type

DISCUSSION:

The present study demonstrated an anastomotic leakage rate of 23.9% following primary repair of acute colonic injury, which aligns closely with contemporary literature reporting rates between 8.3% and 25% in patients with trauma. This finding is consistent with several recent investigations that examined anastomotic complications in colonic trauma management. A meta-analysis by researchers examining primary repair versus diversion in colonic injuries found an overall leak rate of 4.63% in stable patients, although this figure rose significantly in critically ill patients undergoing damage control surgery to 16.7% versus 3.2% in non-damage control cases. The higher leakage rate observed in our study may be attributed to the inclusion criteria focusing specifically on acute traumatic injuries, where tissue viability and healing capacity are often compromised compared with elective procedures.

Our results revealed that penetrating trauma was associated with significantly higher anastomotic leakage rates than blunt trauma, with leakage rates of 29.3% and 17.9%, respectively. This finding is supported by recent evidence from damage control surgery studies, in which penetrating colonic trauma managed with delayed anastomosis demonstrated leak rates of 25%, particularly in patients requiring extended damage control procedures. The mechanisms underlying this increased risk of penetrating trauma likely involve greater tissue devitalization, bacterial contamination, and the associated inflammatory responses that impair wound healing. Contemporary studies have consistently shown that penetrating injuries,

especially those involving firearms, create zones of tissue necrosis that extend beyond the visible injury margins, thereby compromising anastomotic integrity.¹³

The association between associated injuries and increased anastomotic leakage observed in our study, with leak rates of 29.5% versus 17.2% in isolated injuries, reflects physiological stress and compromised healing capacity in polytrauma patients. Recent investigations have identified multiple traumas as an independent risk factor for anastomotic complications, with studies demonstrating that patients with injury severity scores above certain thresholds experience significantly higher complication rates. This relationship is likely mediated through a systemic inflammatory response, altered perfusion dynamics, and metabolic demands of multiple injury healing processes that compete for available resources.

Our findings regarding prolonged hospital stay in patients with anastomotic leakage, with a median stay of 19 versus 8 days, are consistent with recent studies demonstrating that anastomotic complications significantly extend hospitalization periods. A Korean nationwide study demonstrated that patients with anastomotic leakage had significantly longer hospital stays with a mean of 16.78 days compared to 14.22 days in patients without leakage.¹⁵ This prolonged hospitalization reflects not only the direct management of the leak but also the cascade of complications including sepsis, additional procedures, and delayed recovery that characterize these cases.

The mortality rate of 11.8% in patients with anastomotic leakage compared with 1.9% in those without leakage demonstrates the severe clinical impact of this complication. Recent literature reports that mortality rates associated with anastomotic leakage vary significantly, with a 30-day hospital mortality rate of 3.2% after anastomotic leakage compared to 2.1% for all anterior resections, although the rates can be higher in trauma populations. Meta-analysis data showed an average anastomotic leak rate of 9%, postoperative mortality caused by leakage of 0.7%, and an overall postoperative mortality of 2%.¹⁷ Patients with anastomotic leakage had a higher postoperative mortality rate than those with no leakage (4.3 versus 1.2 percent).¹⁸

The high reoperation rate of 47.1% in patients with anastomotic leakage versus 1.9% in those without complications reflects that aggressive intervention is often required to manage these complications. Recent studies have reported that 25% of patients with colonic perforation require resurgery, with 12% experiencing anastomotic leakage.¹⁹

Age-related trends observed in our study, although not statistically significant, align with recent evidence suggesting that older patients face increased risks of anastomotic complications. The mechanisms underlying age-related increased risk include compromised tissue healing capacity, reduced physiological reserve, and a higher prevalence of comorbidities that impair wound healing.

The influence of body mass index on anastomotic outcomes, while approaching statistical significance in our study, reflects ongoing debates in the current literature. The relationship between BMI and anastomotic healing is complex and involves factors such as tissue perfusion, surgical technique challenges, and metabolic factors that require further investigation.

Current evidence strongly supports the safety and efficacy of primary repair in appropriately selected patients with colonic traumas. Primary repair should be attempted during the initial surgical management of all penetrating colon and intraperitoneal rectal injuries. Diversion of colonic injuries should only be considered if the colon tissue itself is inappropriate for repair because of severe edema or ischemia. There is strong evidence from prospective

randomized trials that the vast majority of colonic injuries can be safely managed by primary repair.²²

The limitations of this study include its single-center design, which may limit the generalizability to other healthcare settings with different resources, expertise levels, and patient populations. The relatively short follow-up period of 15 days may have led to missed delayed anastomotic leaks. The observational design of the study prevents definitive causal inferences about risk factors, and the sample size, while adequate for the primary outcome, may have been insufficient to detect small but clinically significant associations for secondary outcomes. Additionally, the study did not account for important technical factors such as surgeon experience, operative time, or specific anastomotic techniques, which recent literature has identified as significant modifiable risk factors.

Future research should focus on developing robust risk stratification tools that incorporate both patient- and injury-specific factors to guide decision making between primary repair and diversion. Multicenter studies with longer follow-up periods are needed to capture the full spectrum of anastomotic complications and their long-term impacts on patient outcomes. The investigation of novel techniques for assessing tissue viability and perfusion, such as indocyanine green angiography, may help identify patients at the highest risk of anastomotic failure. Additionally, research on the role of perioperative optimization strategies, including nutritional support, antibiotic prophylaxis protocols, and enhanced recovery pathways, could provide evidence-based approaches to reduce anastomotic complications in trauma patients. The development of artificial intelligence and machine learning algorithms to predict anastomotic leakage risk using readily available clinical and laboratory parameters represents a promising area for future research.

CONCLUSION

This study confirms that anastomotic leakage following primary repair of acute colonic injury remains a significant clinical problem, occurring in nearly one-quarter of the patients. Penetrating trauma mechanisms and associated injuries have emerged as important risk factors for anastomotic failure. Its significant impact on patient outcomes,

including increased mortality, prolonged hospitalization, and high reoperation rates, underscores the importance of careful patient selection and vigilant postoperative monitoring. While primary repair remains the preferred approach for most colonic injuries, these findings support the need for continued research on risk stratification tools and preventive strategies to optimize outcomes in these challenging patient populations.

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ETHICAL APPROVAL:

The Ethical Committee of Lady Reading Hospital has approved this study with *Ref. No. 449 /LRH/MTI*.

CONFLICT OF INTEREST/DISCLOSURE:

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AUTHORS' CONTRIBUTION:

SSR: Study conception, design, drafting, data analysis, interpretation

AUA: Supervision and critical revision

NA: Data collection and organizing patient records

FA: Assisted in data collection, analysis and clinical results

MD: Assisted in data collection

HAB: Assisted in literature review

REFERENCES:

1. Cullinane DC, Jawa RS, Como JJ, Moore AE, Morris DS, Cheriyan J, et al. Management of penetrating intraperitoneal colon injuries: a meta-analysis and practice management guideline from the Eastern Association for the Surgery of Trauma. *J Trauma Acute Care Surg.* 2019;86(3):505-15. doi: 10.1097/TA.0000000000002146
2. Ott MM, Norris PR, Diaz JJ, Collier BR, Jenkins JM, Gunter OL, et al. Colon anastomosis after damage control laparotomy: recommendations from 174 trauma colectomies. *J Trauma Acute Care Surg* 2011;70(3):595-602. doi: 10.1097/TA.0b013e31820b5dbf
3. Oliveira A, Faria S, Gonçalves N, Martins A, Leão P. Surgical approaches to colonic and rectal anastomosis: systematic review and meta-analysis. *Int J Colorectal Dis.* 2023;38(1):52-6. doi: 10.1007/s00384-023-04328-6
4. Davis B, Rivadeneira DE. Complications of colorectal anastomoses; Leaks, Strictures, and Bleeding. *Surg Clin North Am* 2013;93(1):61-87. doi: 10.1016/j.suc.2012.09.014
5. De Robles MS, Young CJ. Outcomes of primary repair and anastomosis for traumatic colonic injuries in a tertiary trauma center. *Medicina.* 2020;56(9):440-5. doi: 10.3390/medicina56090440
6. Causey MW, Rivadeneira DE, Steele SR. Historical and current trends in colon trauma. *Clin Colon Rectal Surg* 2012;25(4):189-99. doi: 10.1055/s-0032-1329389
7. Denbow DM. Gastrointestinal anatomy and physiology. *Physiology.* 2015;25(17):337-66. doi: 10.1016/B978-012747605-6/50013-4
8. Volk N, Lacy B. Anatomy and physiology of the small bowel, *Gastrointest Endosc Clin.* 2017;27(1):1-3. doi: 10.1016/j.giec.2016.08.001
9. Khan A, Khurshid M, Israr S, Saeed F, Khan K, Ahmed I. Frequency of leakage in primary Repair of Acute Colonic Injury. *Med Forum.* 2022;33(11):51.

10. Zheng YX, Chen L, Tao SF, Song P, Xu SM. Diagnosis and management of colonic injuries following blunt trauma. *World J Gastroenterol.* 2007;13(4):633-6. doi: 10.3748/wjg.v13.i4.633
11. Kumar S, Thakur A, Singh P, et al. Meta-analysis on surgical management of colonic injuries in trauma: to divert or to anastomose? *Int J Colorectal Dis.* 2021;36(10):2143-2154.
12. Morrison CA, Varga CM, Wilson SE, et al. Penetrating colonic trauma and damage control surgery: Anastomosis or stoma? *ANZ J Surg.* 2021;91(9):1747-1752.
13. Stefanopoulos PK, Filippakis K, Soupiou OT, Pazarakiotis VC. Wound ballistics of firearm-related injuries-part 1: missile characteristics and mechanisms of soft tissue wounding. *Int J Oral Maxillofac Surg.* 2014;43(12):1445-58. doi: 10.1016/j.ijom.2014.07.0334-9077238
14. Anjaria DJ, Ullmann TM, Lavery R, et al. Management of colonic injuries in the setting of damage-control laparotomy: one shot to get it right. *J Trauma Acute Care Surg.* 2014;76(3):594-600.
15. Kang J, Kim H, Park H, Lee B, Lee KY. Risk factors and economic burden of postoperative anastomotic leakage related events in patients who underwent surgeries for colorectal cancer. *PLoS One.* 2022;17(5):e0267950. doi: 10.1371/journal.pone.0267950
16. Ashraf SQ, Burns EM, Jani A, Altman S, Young JD, Cunningham C, et al. The economic impact of anastomotic leakage after anterior resections in English NHS hospitals: are we adequately remunerating them? *Colorectal Dis.* 2013;15(4):e190-8. doi: 10.1111/codi.12125
17. Snijders HS, Wouters MW, van Leersum NJ, Kolfschoten NE, Henneman D, de Vries AC, et al. Meta-analysis of the risk for anastomotic leakage, the postoperative mortality caused by leakage in relation to the overall postoperative mortality. *Eur J Surg Oncol.* 2012;38(11):1013-9. doi: 10.1016/j.ejso.2012.07.111
18. Ptok H, Marusch F, Meyer F, Schubert D, Gastinger I, Lippert H; Study Group Colon/Rectum Carcinoma (Primary Tumour). Impact of anastomotic leakage on oncological outcome after rectal cancer resection. *Br J Surg.* 2007;94(12):1548-54. doi: 10.1002/bjs.5707
19. Brunner M, Gärtner L, Weiß A, Weber K, Denz A, Krautz C, et al. Risk Factors for Postoperative Major Morbidity, Anastomotic Leakage, Re-Surgery and Mortality in Patients with Colonic Perforation. *J Clin Med.* 2024;13(17):5220. doi: 10.3390/jcm13175220
20. Üreyen O, İlhan E, Dadalı E, Gökçelli U, Alay D, Altıntaş SB, Tekeli MT. Evaluation of Factors Associated with Anastomotic Leakage in Colorectal Surgery. *Turk J Colorectal Dis.* 2018;28(3):129-135. doi:10.4274/tjcd.53386.
21. Papadopoulos VN, Michalopoulos A, Apostolidis S, Paramythiotis D, Ioannidis A, Mekras A, Panidis S, Stavrou G, Basdanis G. Surgical management of colorectal injuries: colostomy or primary repair? *Tech Coloproctol.* 2011;15 Suppl 1:S63-6. doi: 10.1007/s10151-011-0734-0
22. Tzovaras G, Hatzitheofilou C. New trends in the management of colonic trauma. *Injury.* 2005;36(9):1011-5. doi: 10.1016/j.injury.2004.11.020