Original Research Article

STUDY ON RISK FACTORS ASSOCIATED WITH ANASTOMOTIC LEAKAGE IN GASTROINTESTINAL SURGERIES

ABSTRACT:

Aims: To study the risk factors associated with anastomotic leakage in Gastrointestinal surgery and to study the measures by which these complications can be minimized and managed in a better way.

Study design: This was a prospective observational study

Place and Duration of Study: Conducted in the Post Graduate Department of Surgery, Government Medical College Jammu, over a period of one year from 1st November 2019 to 31st October 2020.

Methodology: 102 patients who had undergone gastrointestinal anastomosis irrespective of age and gender were included in the study. The patients were thoroughly evaluated and pre operative and post operative details were noted followed by analysis of risk factors associated with those who had anastomotic leaks pos operatively were analysed and results obtained.

Results: Distribution of anastomotic leak was comparable in elective and emergency (5.06% v/s8.70% respectively) .Proportion of anastomotic leak was significantly higher in >25 body mass index as compared to <25 body mass index (27.27% v/s3.30% respectively, significantly higher in anaemic (Hb<10gm%) as compared to non- anemic (Hb>10 gm%) (16.67% v/s2.56% respectively), higher in hypoalbuminemia (<3.5g/dL) as compared to patients with albumin (>3.5g/dL) (17.39% v/s2.53% respectively) .Proportion of anastomotic leak was significantly higher in patients with history of radiotherapy as compared to patients without history of radiotherapy (66.67% v/s 4.04% respectively)). Comorbidities also contributed to higher rate of anastomotic leak(diabetes mellitus, hypertension, COPD, bronchial asthma, tuberculosis, malignancy and others) (25% v/s0% v/s33.33% v/s0% v/s16.67% v/s20% v/s0% respectively)

Key words: *Anastomotic leak, risk factors, prevention, management.*

1. INTRODUCTION:

The word anastomosis comes from the Greek word '*ana*', without, and *'stoma',* a mouth, reflecting the join of a tubular viscus like bowel after a resection. Bowel anastomosis is the procedure done in order to establish communication between two formerly distant portions of the bowel.

Intestinal anastomosis is associated with number of complications like anastomotic leak, bleeding, wound infection, anastomotic stricture and prolonged functional ileus especially in children. Among the postoperative complications, anastomotic leakage is still the most feared complication.[1]

Anastomotic leak is defined as a defect at the anastomotic site leading to a communication between intraluminal and extraluminal compartments [17-20]. This communication can be confirmed radiographically, endoscopically or intra operatively. There is a wide range of clinical features depending on the grade of leak. Gastrointestinal surgery-associated anastomotic leaks have been a major reason behind post-operative morbidity and mortality irrespective of the continual improvements in surgical procedures.[2] Anastomotic leakage leads to increased hospital stay and puts significant burden on the health care providers and patients, besides the possible negative clinical outcomes.[3] The management depends on grade of severity ranging from those requiring laparotomy vs those who do not. Knowledge of various risk factors leading to anastomotic leakage can help the surgeon to adopt measures which would help in bringing down the incidence of the anastomotic leakage and further promote better clinical outcome.

2. MATERIAL & METHODS:

2.1 AIMS AND OBJECTIVES:

To study the risk factors associated with anastomotic leakage in Gastrointestinal surgery.
To study the measures by which these complications can be minimized and managed in a better way.

This study was a prospective observational study conducted in the Post Graduate Department of Surgery, Government Medical College Jammu, over a period of one year from 1st November 2019 to 31st October 2020 where in 102 patients who had undergone gastrointestinal anastomosis irrespective of age and gender were included in the study.

2.2 INCLUSION CRITERIA:

- All the patients who are undergoing gastrointestinal anastomosis for various indications irrespective of age and gender.
- Both emergency and elective cases.

2.3 EXCLUSION CRITERIA:

- Patients having tumour recurrence or metastasis
- Patients who underwent palliative stoma
- Patients not giving consent for surgery

Patients fulfilling the inclusion criteria were subjected to complete history, demographic data, physical examination, laboratory and radiological investigations were noted.

The operative details which were noted are as follows:
Emergency v/s elective procedure , presence or absence of sepsis (intra-abdominal contamination), use of vasopressors, peritonitis, type of anastomosis: Hand Sewn v/s stapler, Single v/s double layer, EEA v/s ESA v/s SSA, location of anastomosis ,Intestinal condition presence or absence of Bowel obstruction, Surgical time, Combined organ resection, Quantity of blood loss,Abdominal drainage (insertion of abdominal drains), Drainage location,Curative v/s palliative surgical methods, Operative blood /blood transfusion products and Perioperative use of corticosteroids
In post operative observation the following parameters were studied:
Vitals monitoring and charting , abdominal girth monitored daily.
Nasogastric tube contents and abdominal drains were examined daily for quantity, colour, odour etc.
Routine investigations like CBC, RFT, LFT, PTI, ABG etc. were done on daily basis / alternate basis.
Patients with any of these features like diffuse abdominal tenderness, guarding, rigidity, abdominal distension, absent bowel sounds, fever, leukocytosis, tachycardia, hypotension, diarrhea etc.
were further evaluated by USG abdomen, X-ray abdomen, CECT abdomen, endoscopy etc.
Patients who were diagnosed with anastomotic leaks were managed accordingly.
The severity of anastomotic leaks is defined on the basis of clinical management required. Grade A leaks are those managed without an invasive intervention, Grade B leaks are those managed with invasive intervention other than a laparotomy (e.g., percutaneous drainage) and Grade C are those requiring laparotomy
Following are the important points that were noted in those with anastomotic leaks:
1. Duration of hospital stay.
2. Post-operative ICU stay.
3.Day of diagnosis of leak
4. Management– Surgical v/s Conservative.
5.Complications other than anastomotic leak. 6. Outcome of anastomotic leak.

2.4 DATA ANALYSIS / STATISTICAL ANALYSIS

The presentation of the Categorical variables was done in the form of number and percentage (%). On the other hand, the presentation of the continuous variables was done as mean ± SD and median values. The following statistical tests were applied for the results:

- The association of the variables which were quantitative in nature were analysed using Independent t test (for two groups).
- The association of the variables which were qualitative in nature were analysed using Fisher's Exact test.
- Univariate and multivariate logistic regression was used to find out significant risk factors of anastomotic leak.

2.5 STATISTICAL ANALYSIS

The data entry was done in the Microsoft EXCEL spreadsheet and the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software version 21.0.

For statistical significance, p value of less than 0.05 was considered as significant.

3. RESULTS & DISCUSSION:

1. AGE DISTRIBUTION & ASSOCIATION OF AGE WITH ANASTOMOTIC LEAK(S):

Majority (18.63%) of patients belonged to age group 31-40 years and only 10.78% belongs to 51-60 years age group. Mean value of age(years) of study subjects was 37.63 ± 21.4 with median (25th-75th percentile) of 38.5(20.75-54.75). Mean ± SD of age(years) in anastomotic leak was 57.33 ± 9.83 and in patients without anastomotic leak was 36.4 ± 21.37.

Table 1: Association Of Age With Anastomotic Leak(S):

Age (years)	No anastomotic leak (n=96)	Anastomotic leak (n=6)	Total	P value	Test performed
0-10	13 (100%)	0 (0%)	13 (100%)	0.163	Fisher Exact test
11-20	13 (100%)	0 (0%)	13 (100%)		
21-30	16 (94.12%)	1 (5.88%)	17 (100%)		
31-40	15 (78.95%)	4 (21.05%)	19 (100%)		
41-50	13 (100%)	0 (0%)	13 (100%)		
51-60	11 (100%)	0 (0%)	11 (100%)		
>60	15 (93.75%)	1 (6.25%)	16 (100%)		
Total	96 (94.12%)	6 (5.88%)	102 (100%)		

2. GENDER DISTRIBUTION AND ASSOCIATION OF GENDER WITH ANASTOMOTIC LEAK

In present study, 64.71% of patients were males and 35.29% of patients were females. Distribution of anastomotic leak was comparable in female and male (5.56% v/s 6.06% respectively) (p value = 1)

Table 2: Association of gender with anastomotic leak.

Gender	No anastomotic leak (n=96)	Anastomotic leak (n=6)	Total	P value	Test performed
Female	34 (94.44%)	2 (5.56%)	36 (100%)	1	Fisher Exact test
Male	62 (93.94%)	4 (6.06%)	66 (100%)		

Total	96 (94.12%)	6 (5.88%)	102 (100%)		

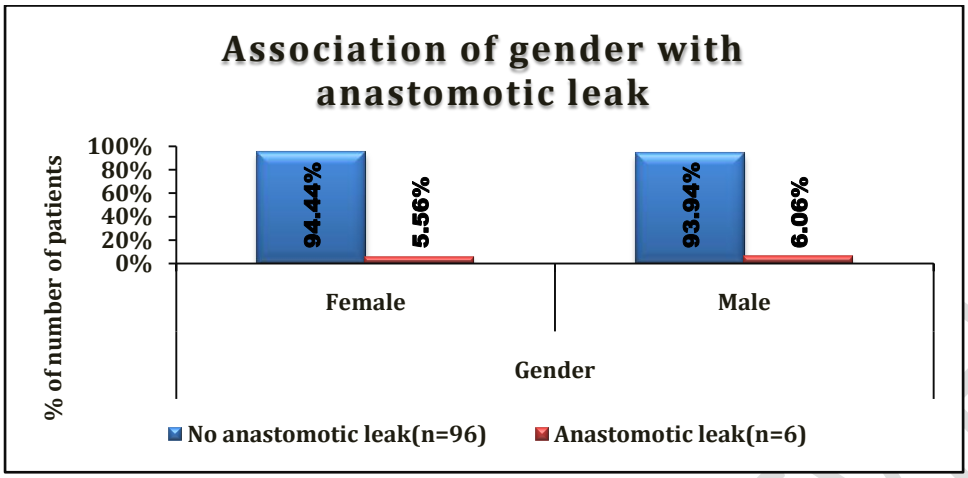

Figure 1 :Association of gender with anastomotic leak

3. PRESENTATION OF STUDY SUBJECTS

In majority (67.65%) of patients, stoma closure was done. Out of 69 patients, in majority (72.46%) of patients' small bowel stoma closure was done followed by large bowel (26.09%). Ileo-colic was done in only 1 out of 69 patients (1.45%).

In present study, Peritonitis was present in only 4 out of 102 patients (3.92%), out of which, 50% of patients had spontaneous perforation and 50% had traumatic perforation.

Obstruction was present in only 29 out of 102 patients (28.43%). Out of 29 patients, 37.93% of patients had large bowel and small bowel obstruction each, followed by gastric outlet obstruction (24.14%). This is represented in *Table 3* and *Figure 2.*

Table 3: Distribution of presentation of study subjects.

Presentation	Frequency	Percentage
Peritonitis		
No	98	96.08%
Yes	4	3.92%
Type of peritonitis		
Spontaneous perforation	2	50.00%
Traumatic perforation	2	50.00%

Obstruction		
No	73	71.57%
Yes	29	28.43%
Type of obstruction		
Gastric outlet obstruction	7	24.14%
Large bowel obstruction	11	37.93%
Small bowel obstruction	11	37.93%
Stoma closure		
No	33	32.35%
Yes	69	67.65%
Type of stoma closure		
Ileo-colic	1	1.45%
Large bowel	18	26.09%
Small bowel	50	72.46%

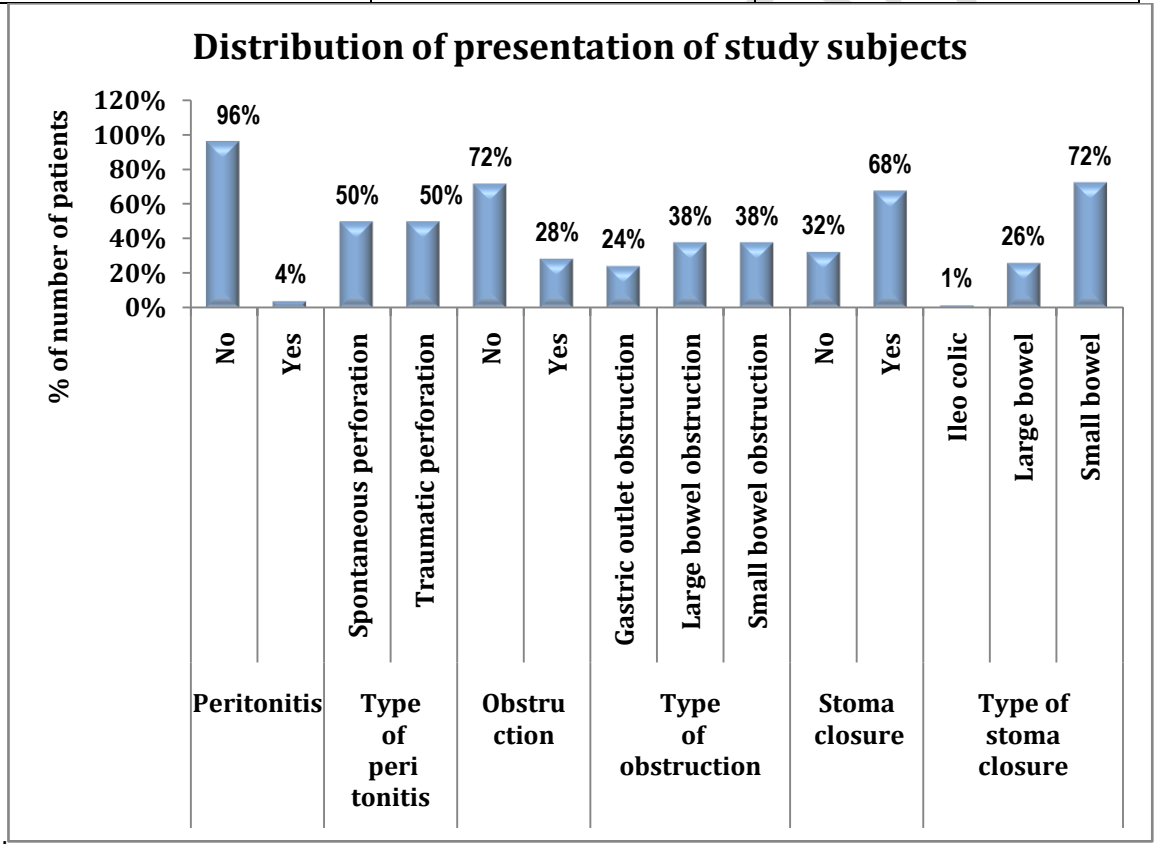

Figure 2: Distribution of presentation of study subjects.

4. EMERGENCY V/S ELECTIVE & ASSOCIATION WITH ANASTOMOTIC LEAK:

In present study, majority (77.45%) of cases were elective and only 23 out of 102 patients (22.55%) were emergency cases.

Distribution of anastomotic leak was comparable in elective and emergency (5.06% v/s8.70% respectively) (p value = 0.615).

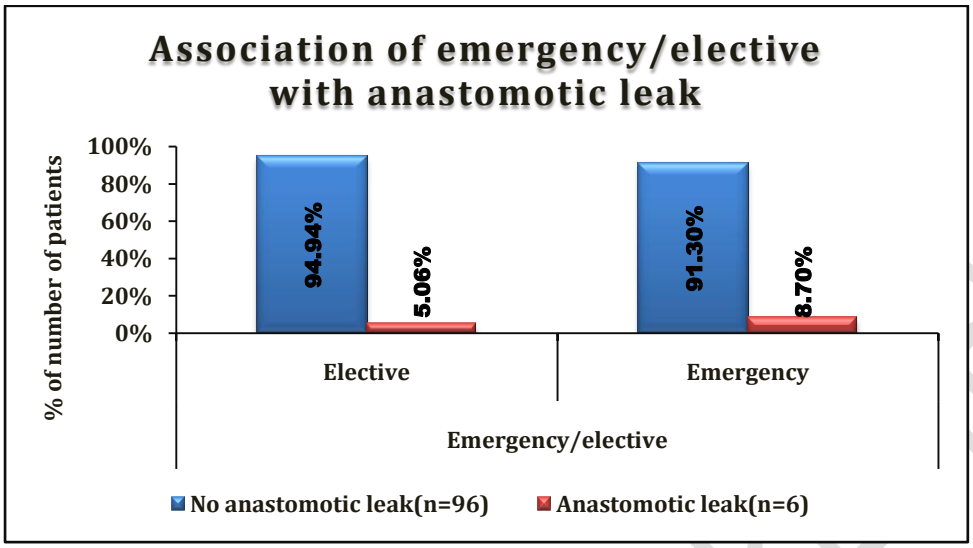

Figure 3: Association of emergency/elective with anastomotic leak

5. SMOKING DISTRIBUTION:

In our study majority (62.75%) of patients were non-smokers and only 38 out of 102 patients (37.25%) were smokers.

Proportion of anastomotic leak was significantly higher in smokers as compared to non-smokers (13.16% v/s1.56% respectively) (p value = 0.026).

Table 4: Distribution of smoking of study subjects.

Smoking	Frequency	Percentage
Non-smokers	64	62.75%
Smokers	38	37.25%
Total	102	100.00%

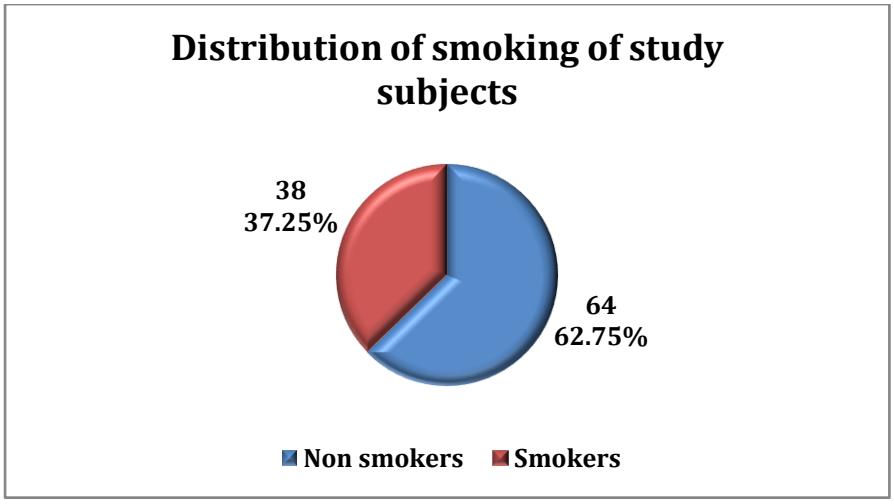

Figure 4 : Distribution of smoking in study subjects

Table 5 : Association of smoking with anastomotic leak.

Smoking	No anastomotic leak (n=96)	Anastomotic leak (n=6)	Total	P value	Test performed
Non smokers	63 (98.44%)	1 (1.56%)	64 (100%)	0.026	Fisher Exact test
Smokers	33 (86.84%)	5 (13.16%)	38 (100%)		
Total	96 (94.12%)	6 (5.88%)	102 (100%)		

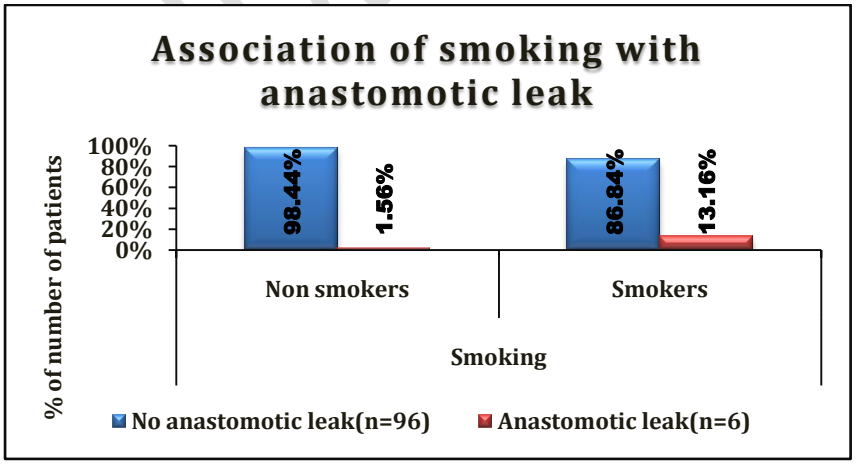

Figure 5 : Association of smoking with anastomotic leak

6. BMI DISTRIBUTION:

As shown in *Figure 6*, in majority of patients (89.21%) in our study, body mass index (kg/m²) was <25. Body mass index(kg/m²) was >25 of only 11 out of 102 patients (10.78%). Proportion of anastomotic leak was significantly higher in >25 body mass index as compared to <25 body mass index (27.27% v/s3.30% respectively) (p value = 0.016).

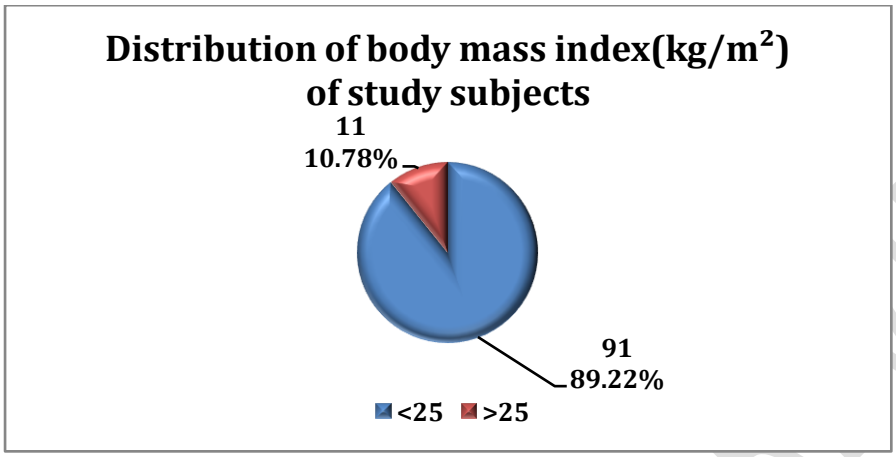

Figure 6 : Distribution of BMI of study subjects

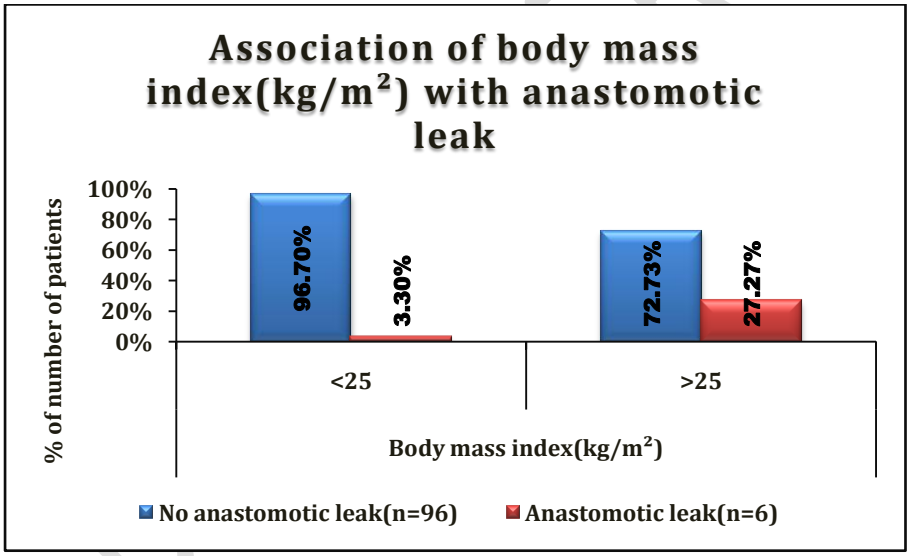

Figure 7: Association of BMI with anastomotic leak

7. HEMOGLOBIN DISTRIBUTION:

In present study, majority (76.47%) of patients had hemoglobin (gm%) >10 gm%. Only 24 out of 102 patients (23.53%) had Hemoglobin < 10gm%.

Proportion of anastomotic leak was significantly higher in anemic (Hb<10gm%) as compared to non-anemic (Hb>10 gm%) (16.67% v/s2.56% respectively) (p value = 0.026).

Table 6: Distribution of hemoglobin(gm%) of study subjects.

Hemoglobin(gm%)	Frequency	Percentage
Anemia (Hb<10gm%)	24	23.53%
Hb>10 gm%	78	76.47%
Total	102	100.00%

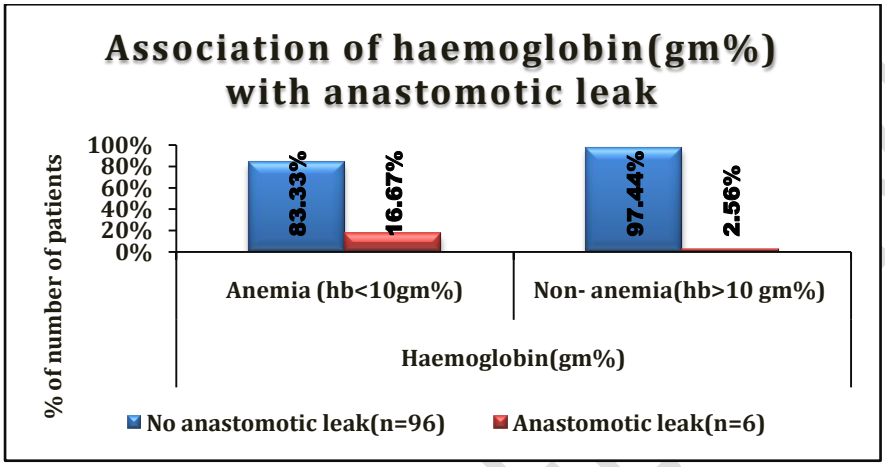

Figure 8: Association of hemoglobin (gm%) with anastomotic leak

8. ALBUMIN DISTRIBUTION:

In present study, majority (77.45%) of patients had albumin (g/dL) >3.5g/dl. Only 23 out of 102 patients (22.55%) had hypoalbuminemia (albumin <3.5 g/dl). Proportion of anastomotic leak was significantly higher in hypoalbuminemia (<3.5g/dL) as compared to patients with albumin (>3.5g/dL) (17.39% v/s2.53% respectively) (p value = 0.022).

Table 7: Distribution of albumin(g/dL) of study subjects.

Albumin(g/dL)	Frequency	Percentage
Albumin >3.5g/dL	79	77.45%
Hypoalbuminemia (<3.5g/dL)	23	22.55%
Total	102	100.00%

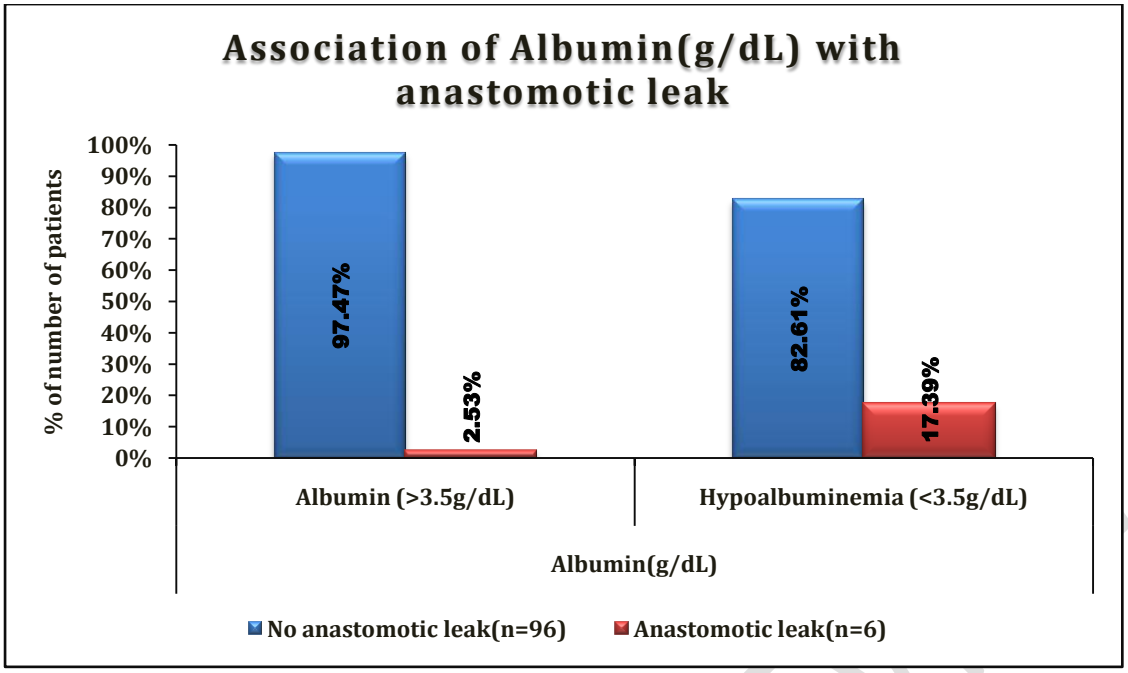

Figure 9: Association of albumin (g/dl) with anastomotic leak

9. DISTRIBUTION OF HISTORY OF RADIOTHERAPY:

In the present study, majority (97.06%) of patients, history of radiotherapy was absent. History of radiotherapy was present in only 3 out of 102 patients (2.94%).

As depicted in *Figure 10*, proportion of anastomotic leak was significantly higher in patients with history of radiotherapy as compared to patients without history of radiotherapy (66.67% v/s 4.04% respectively) (p value = 0.009).

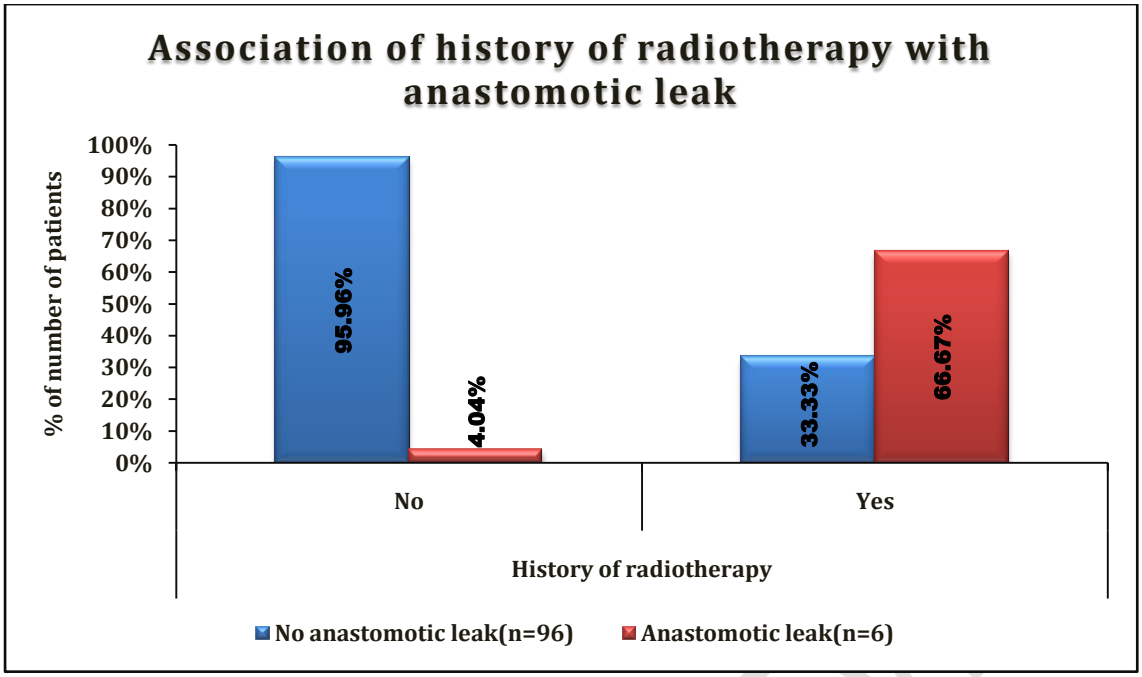

Figure 10 : Association of history of radiotherapy with anastomotic leak

10. DISTRIBUTION OF COMORBIDITIES:

In present study, in majority (70.59%) of patients, comorbidity was absent. Comorbidity was present in only 30 out of 102 patients (29.41%).

In majority of patients, malignancy(33.33%) was present as comorbidity followed by tuberculosis (20.00%), diabetes mellitus (13.33%), hypertension (13.33%), COPD (10.00%) ,Bronchial asthma (3.33%).and others (6.67%).

Proportion of anastomotic leak was significantly higher in patients with comorbidity as compared to patients without comorbidity (16.67% v/s1.39% respectively) (p value = 0.008). Distribution of anastomotic leak was comparable in type of comorbidity (diabetes mellitus, hypertension, COPD, bronchial asthma, tuberculosis, malignancy and others) (25% v/s0% v/s33.33% v/s0% v/s16.67% v/s20% v/s0% respectively) (p value = 0.97).

*Malignancy group- This includes two patients who had received radiotherapy also. Therefore, two patients in our study had both malignancy and radiotherapy as risk factor.

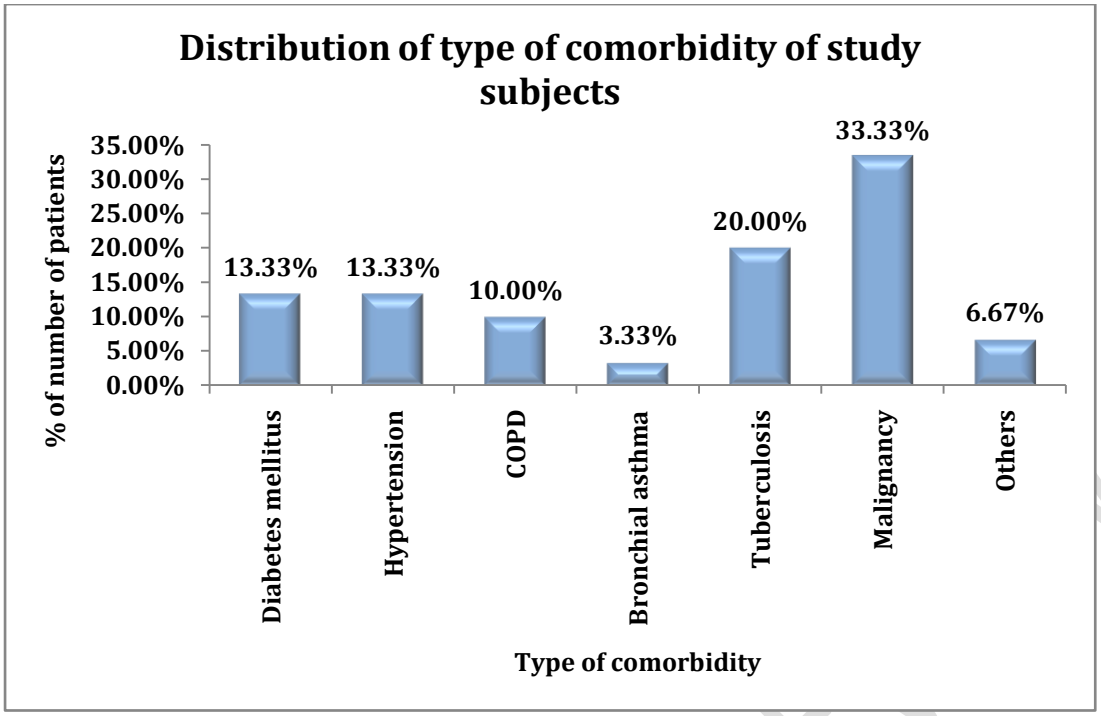

Figure 11: Distribution of type of comorbidity of study subjects

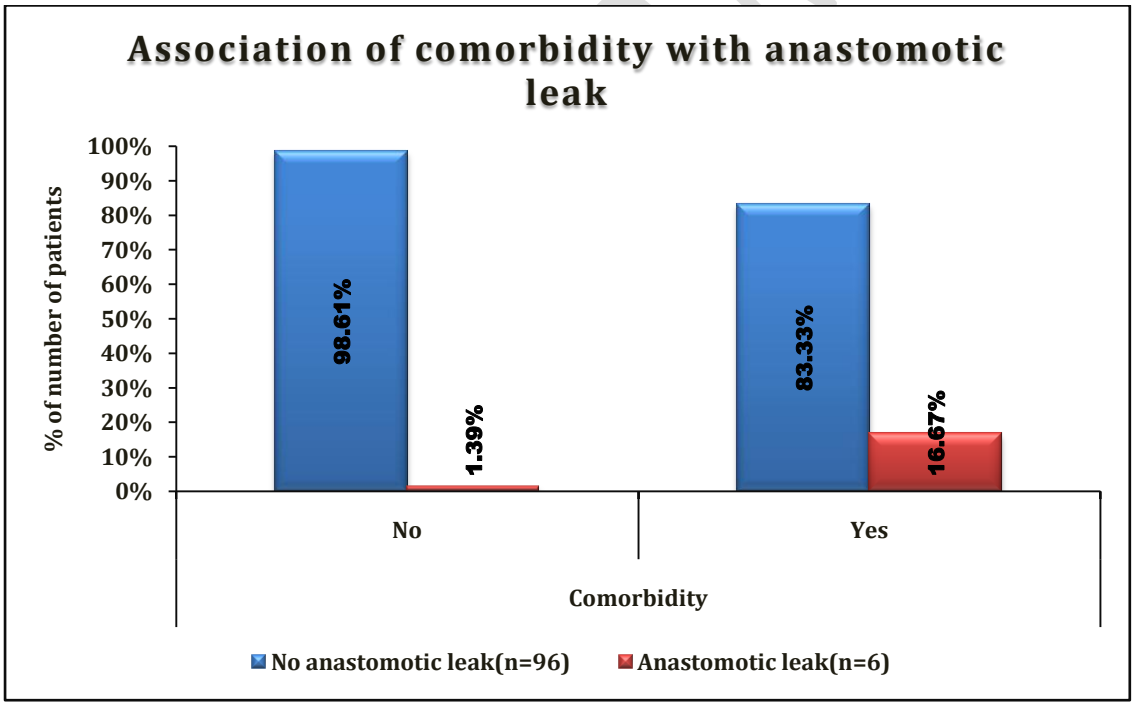

Figure 12: Association of comorbidity with anastomotic leak

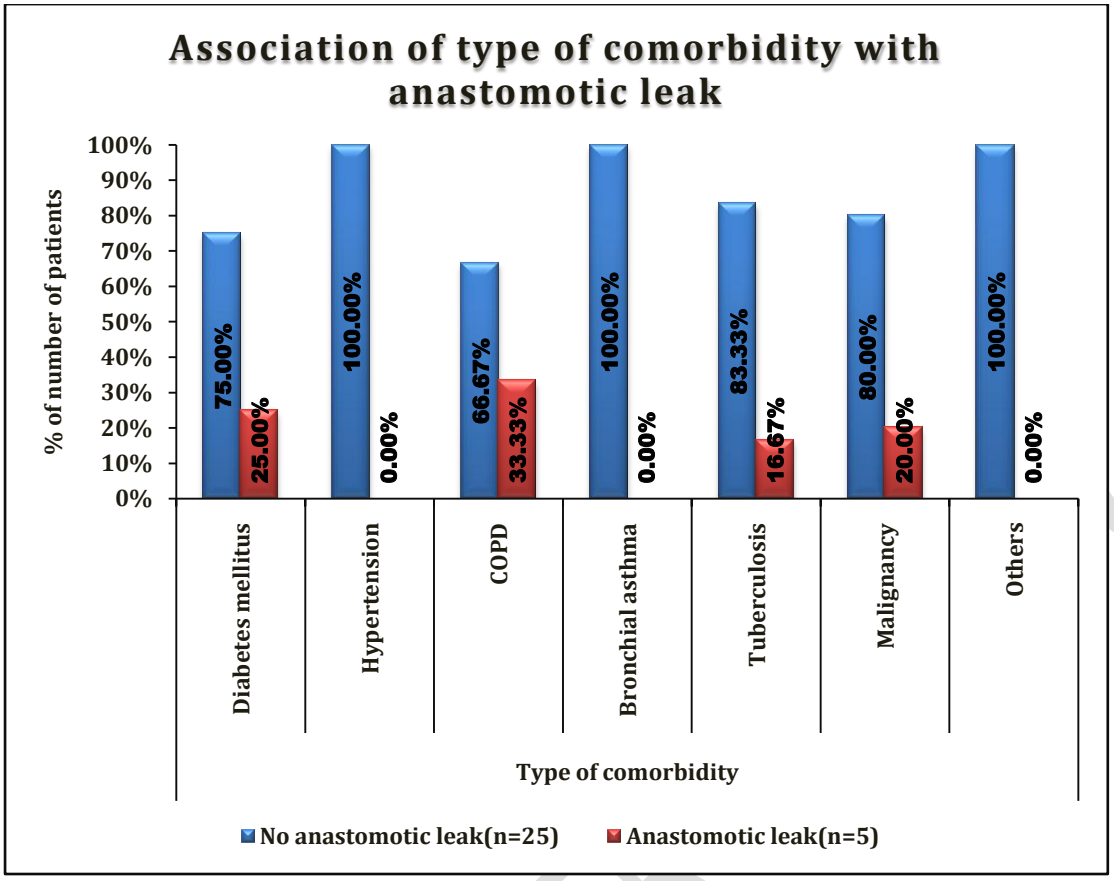

Figure 13: Association of type of comorbidity with anastomotic leak

11. DISTRIBUTION OF ASA SCORE AND ASSOCIATION OF ANASTOMOTIC LEAK:

Majority (67.65%) of patients had ASA score <3. ASA score was >=3 in only 33 out of 102 patients (32.35%). Mean value of ASA score of study subjects was 2.34 ± 1.16 with median (25th-75th percentile) of 2(2-3).

The proportion of anastomotic leak was significantly higher in patients with >=3 ASA score as compared to <3 ASA score (15.15% v/s1.45% respectively) (p value = 0.013). Mean ± SD of ASA score in patients without anastomotic leak was 2.29 ± 1.17 and with anastomotic leak was 3.17 ± 0.75.

Table 8: Distribution of ASA score of study subjects.

ASA score	Frequency	Percentage
<3	69	67.65%
>=3	33	32.35%
Mean ± SD	2.34 ± 1.16	

Median (25th-75th percentile)	2(2-3)
Range	1-5

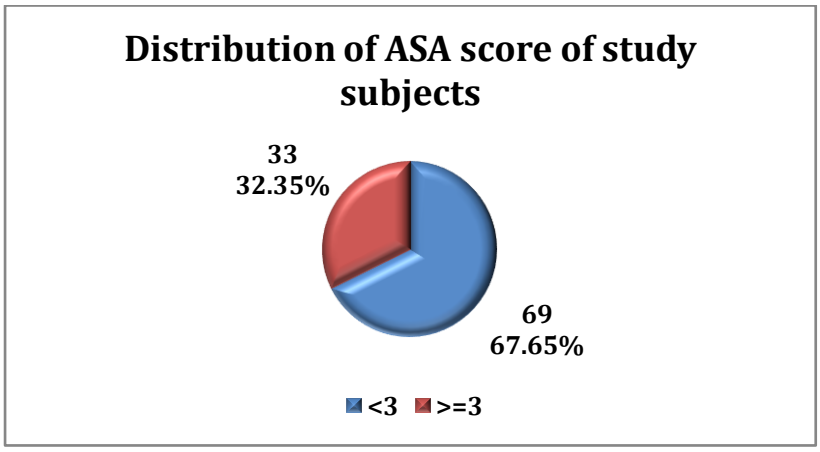

Figure 14: Distribution of ASA score of study subjects

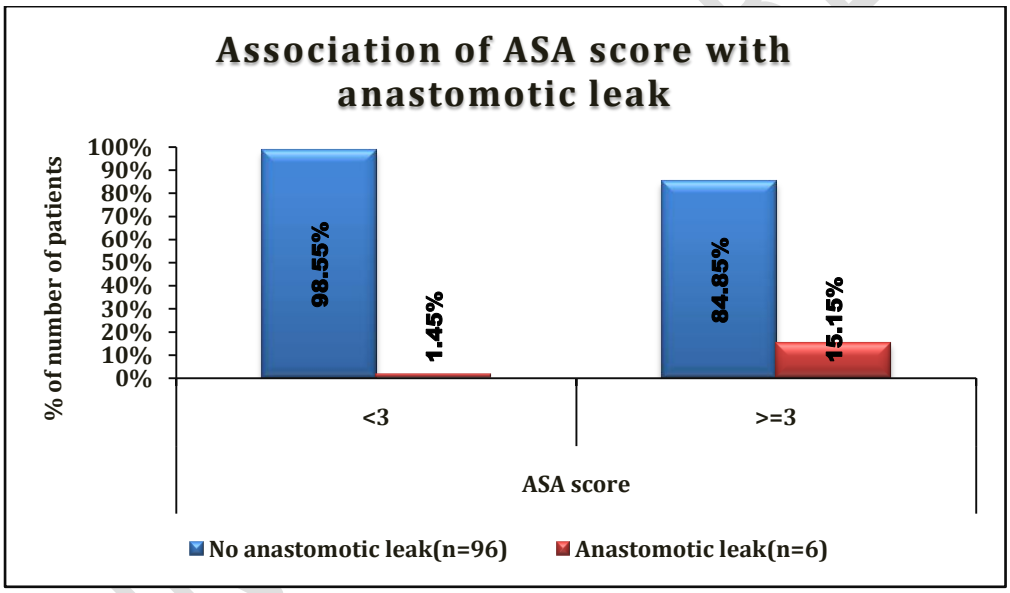

Figure 15: Association of ASA score with anastomotic leak

12. USE OF CORTICOSTEROIDS:

In present study, in majority (91.18%) of patients, corticosteroid was not used. Corticosteroids was used only in 9 out of 102 patients (8.82%).

Proportion of anastomotic leak was significantly higher in patients who used corticosteroids as compared to patients who did not require corticosteroids (33.33% v/s3.23% respectively) (p value = 0.009).

Table 9: Distribution of use of corticosteroids in study subjects.

Corticosteroids	Frequency	Percentage
No	93	91.18%
Yes	9	8.82%
Total	102	100.00%

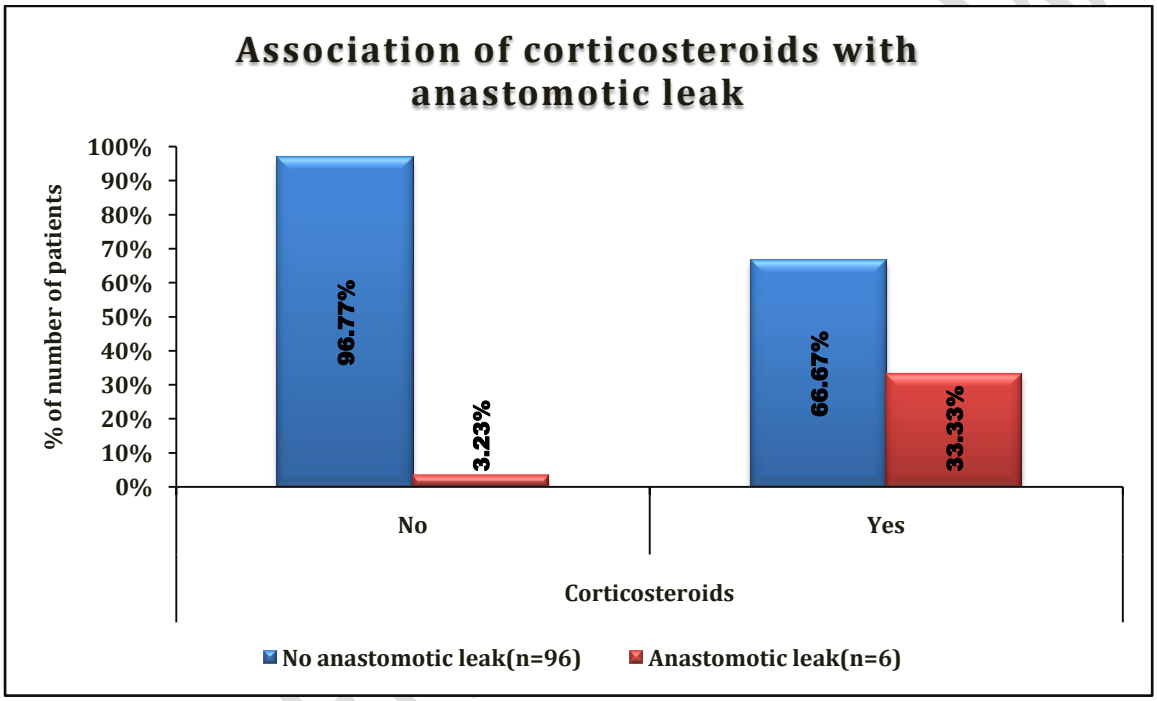

Figure 16: Association of corticosteroids with anastomotic leak

13. INTRAOPERATIVE FACTORS:

SEPSIS: In present study, Sepsis was seen in only 6 out of 102 patients (5.88%). Proportion of anastomotic leak was significantly higher in patients with sepsis as compared to patients without sepsis (50% v/s3.13% respectively) (p value = 0.002).

DURATION OF SURGERY: In 56.86% of patients, duration of surgery (minutes) was 121-180 followed by 60-120 (36.27%). Duration of surgery (minutes) was >180 in only 7 out of 102 patients (6.86%). Mean value of duration of surgery (minutes) of study subjects was 143.63 ± 33.07 with median (25th-75th percentile) of 140(120-150). Proportion of anastomotic leak was significantly higher

in patients with duration of surgery >180 minutes as compared to 60-120 minutes and 121-180 minutes (42.86% v/s2.70%, 3.45% respectively) (p value = 0.005). Mean ± SD of duration of surgery (minutes) in patients without anastomotic leak was 140.94 ± 29.94 and with anastomotic leak was 186.67 ± 51.93.

TECHNIQUE USED: In majority (92.16%) of patients, hand sewn was done and stapler was used in only 8 out of 102 patients (7.84%). In majority (90.20%) of patients, end to end anastomosis was done. End to side and side to side anastomosis was done in 5 each. Distribution of anastomotic leak was comparable in hand sewn v/sstapler (5.32% v/s12.50% respectively) (p value = 0.395). Distribution of anastomotic leak was comparable in type of anastomosis (end to end, end to side and side to side) (5.43% v/s20% v/s0% respectively) (p value = 0.47).

BLOOD TRANSFUSION:In majority (87.25%) of patients, blood transfusion required was <2 (2 units) and only in 12.75% patients >2 blood transfusions were done (12.75%). Proportion of anastomotic leak was significantly higher in patients with blood transfusion>2 as compared to <2 (30.77% v/s2.25% respectively) (p value = 0.002).

VASOPRESSOR USE: Vasopressors were required in only 6 out of 102 patients (5.88%).

Proportion of anastomotic leak was significantly higher in patients who required vasopressors as compared to who did not require vasopressors (33.33% v/s4.17% respectively) (p value = 0.039).

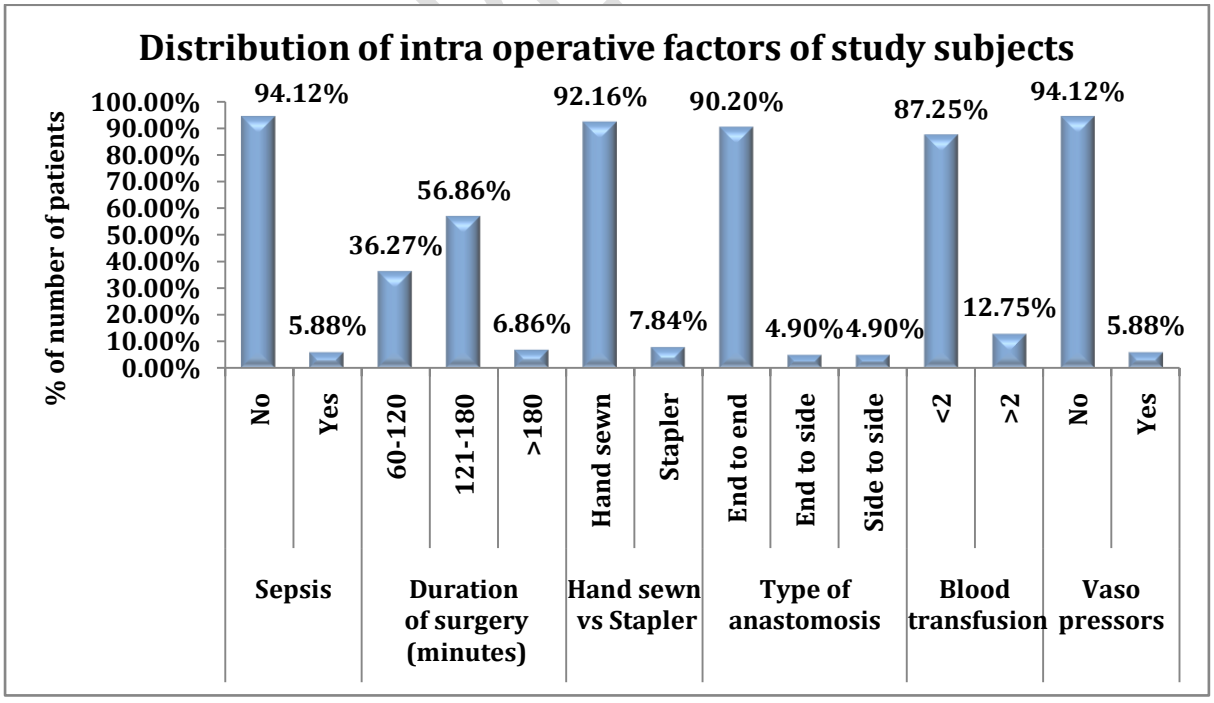

Figure 17: Distribution of intra operative factors of study subjects

Table 10: Association of intra operative factors with anastomotic leak.

Intra operative factors	No anastomotic leak (n=96)	Anastomotic leak (n=6)	Total	P value	Test performed
Sepsis					
No	93 (96.88%)	3 (3.13%)	96 (100%)	0.002	Fisher Exact test
Yes	3 (50%)	3 (50%)	6 (100%)		
Duration of surgery (minutes)					
60-120	36 (97.30%)	1 (2.70%)	37 (100%)	0.005	Fisher Exact test
121-180	56 (96.55%)	2 (3.45%)	58 (100%)		
>180	4 (57.14%)	3 (42.86%)	7 (100%)		
Hand sewn v/s Stapler					
Hand sewn	89 (94.68%)	5 (5.32%)	94 (100%)	0.395	Fisher Exact test
Stapler	7 (87.50%)	1 (12.50%)	8 (100%)		
Type of anastomosis					
End to end	87 (94.57%)	5 (5.43%)	92 (100%)	0.47	Fisher Exact test
End to side	4 (80%)	1 (20%)	5 (100%)		
Side to side	5 (100%)	0 (0%)	5 (100%)		
Blood transfusion					
<2	87 (97.75%)	2 (2.25%)	89 (100%)	0.002	Fisher Exact test
>2	9 (69.23%)	4 (30.77%)	13 (100%)		
Vasopressors					
No	92 (95.83%)	4 (4.17%)	96 (100%)	0.039	Fisher Exact test
Yes	4 (66.67%)	2 (33.33%)	6 (100%)		

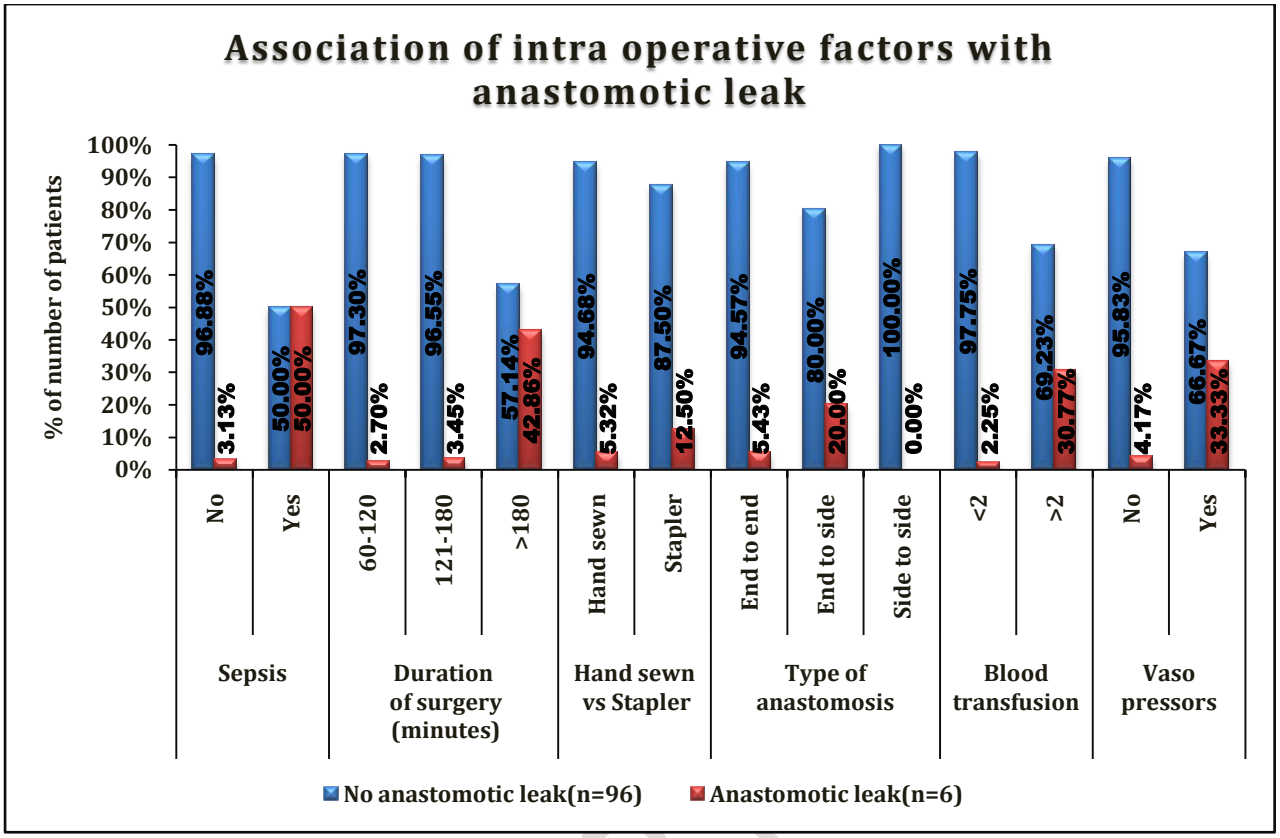

Figure 18: Association of intra operative factors with anastomotic leak

14. MANAGEMENT & OUTCOME OF ANASTOMOTIC LEAK:

In present study, anastomotic leak was seen in only 6 out of 102 patients (5.88%).

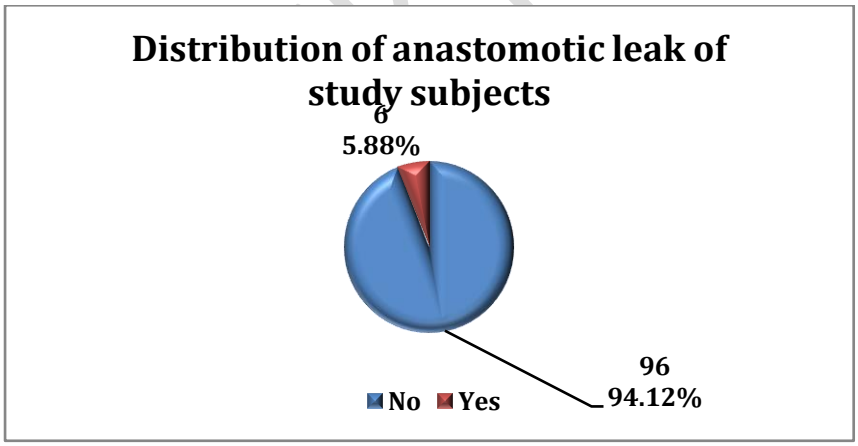

Figure 19: Distribution of anastomotic leak of study subjects

Out of 6 patients with anastomotic leak, 2(33.33%) were managed conservatively and 4(66.66%) were re-explored and proximal diversion was done for these patients. Two (33.33%) patients presenting with anastomotic leak expired.

Table 11: Management and Outcome of patients with anastomotic leak

Anastomotic leaks	Total number	Percentage
Patients with leak	6	100%
Re exploration	4	66.66%
Conservative	2	33.33%
Expired	2	33.33%

15. OVERALL OUTCOME:

In present study, majority (95.10%) of patients were discharged and only 5 out of 102 patients (4.90%) expired.

Table 12: Distribution of outcome of study subjects.

Outcome	Frequency	Percentage
Discharged	97	95.10%
Expired	5	4.90%
Total	102	100.00%

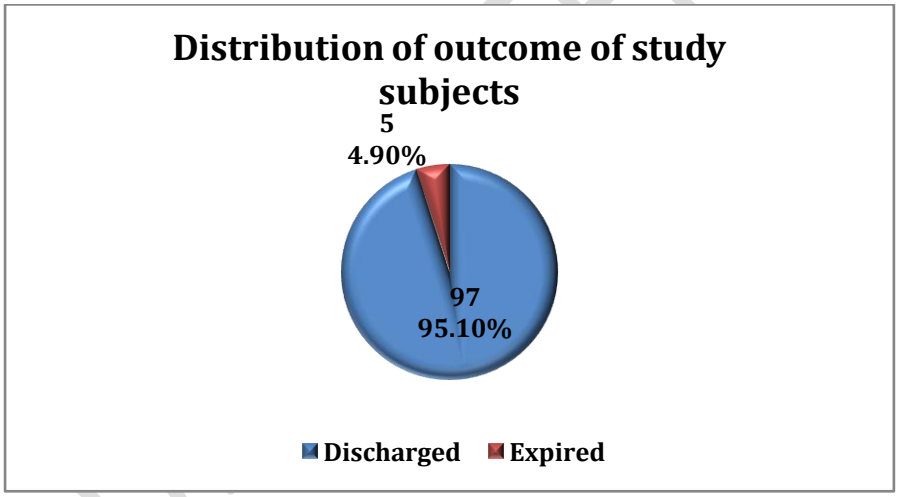

Figure 20: Distribution of outcome of study subjects

3.1 DISCUSSION:

The history of gastrointestinal surgery has undergone various revisions and changes through time encompassing studying different techniques and their associated pros and cons, study of risk factors and timely prevention and management forming the foundation for us today to achieve excellence and provide highest quality healthcare.

Main principles of intestinal anastomosis include: 1. Good blood supply to both bowel ends. 2. Anastomosis is under no tension. 3. Avoid injury to mesenteric vessels. 4. Use atraumatic bowel clamps. 5. Well nourished patient. 6. No distal obstruction. 7. Meticulous surgical technique.

The vascularity of the bowel is the most important factor in the anastomotic healing. The stomach and small bowel are more vascular than the colon and they heal more rapidly. The increased vascularity of the bowel wall is the reason why gastric and small bowel anastomoses heal more rapidly in comparison with those involving the oesophagus and large bowel.

Indications of intestinal anastomosis can be broadly divided into two categories:1. Restoration of bowel continuity following resection of diseased bowel 2. Bypass of unresectable diseased bowel (mostly malignancies).

This study intends to find risk factors associated with anastomotic leakage in GI surgery.

Mean age of patients in our study was 37 years. The highest incidence of anastomotic leak rate was reported in (21.05%) 31–40 years of age group, followed by more than 60 years age group (6.25%).

Table 13: Advanced age association comparison

Study	Year	Advanced age as a risk factor	P value
Kumar A *et al.*[4]	2011	>35%	<0.005
Kshirsagar AY *et al.*[5]	2020	>27.77	<0.005
Present Study	2020	6.25%	>0.05(0.163)

Due to a lack of large sample size, our study couldn't prove any association of age with anastomotic leak as shown in *Table 13.*

In our study, the incidence of the leak was slightly higher in males but this result was not statistically significant (p value > 0.05). Jina A *et al.* reported a 16.85% association of anastomotic leaks with male gender. Kryzauskas M *et al.* in their study reported that male sex is associated with anastomotic leaks in as high as 11.59% of cases.

Table 14: Gender association comparison

Study	Year	Male association	P value
Jina A *et al.*[6]	2019	16.85%	>0.05
Kryzauskas M *et al.*[7]	2020	11.59%	<0.05

Present study	2021	6.06%	>0.05

Komen N *et al.* reported that high BMI was associated with anastomotic leaks in around 29% while Buchs NC *et al*. reported this association in around 25% of the cases.

Table 15: BMI association comparison

Study	Year	BMI association	P value
Buchs NC *et al.*[8]	2008	25%	<0.05
Komen N *et al.*[9]	2009	29.32%	<0.05
Present study	2021	27.27%	<0.05(0.016)

Our results are comparable with other studies done on the said criteria as noted in *Table 15.*
In our study, anemic patients had anastomotic leak in around 16% of cases as compared to 29.41% as seen in study done by Jina A *et al.* 40% reported by Kshirsagar AY *et al.* and around 61% seen in the study of Farghaly AE *et al.*

Table 16: Association of anemia comparison

Study	Year	Anemic patients with anastomotic leak (%)	P value
Jina A *et al.*[6]	2019	29.41%	<0.05
Kshirsagar AY *et al.*[5]	2020	40%	<0.05
Farghaly AE *et al.*[10]	2019	61. 5%	<0.05
Present study	2021	16.67%	<0.05(0.026)

The results of our study are different from other studies in reporting a lower incidence of anastomotic leaks in anaemic patients as compared to data reported in other studies as seen in *Table 16.*

Hypoalbuminemia is one of the important risk factors for anastomotic leak seen in 17.39% in this study. Kshirsagar AY *et al.* reported that 40% of the cases with hypoalbuminemia had anastomotic leaks while Farghaly AE *et al.* reported this number as 92.3%, Telem DA *et al.* as 51% and Jina A *et al.* as 66.6%.

Table 17: Hypoalbuminemia association comparison

Study	Year	Patients with hypoalbuminemia (%)	P value
Telem DA *et al.*[11]	2010	51%	<0.05
Farghaly AE *et al.*[10]	2019	92.3%	<0.05
Jina A *et al.*[6]	2019	66.66%	<0.05
Kshirsagar AY *et al.*[5]	2020	40%	<0.05
Present study	2021	17.39%	<0.05(0.022)

Our study confirmed the association of hypoalbuminemia with anastomotic leak but the number of cases reported were lower than other studies as reported in *Table 17.*

In our study, the association of smoking with anastomotic leak was seen in 13.16% patients which correlates with study done by Baucom RB *et al* where it was 17% as represented in *Table 18.*

Table 18: Association of smoking with anastomotic leak

Study	Year	Smoking (%)	P Value
Baucom RB *et al.*[12]	2015	17%	<0.05
Daele EV *et al.*[13]	2016	67%	<0.05
Present study	2021	13.16%	<0.05(0.026)

In our study the association with an ASA score of >/=3 in patients with anastomotic leak was found to be 15.15% which correlates with 12.68% seen in the study done by Kryzauskas M *et al.* as shown in *Table 19.*

Table 19: Association of ASA score (>/=3) with anastomotic leak

Study	Year	ASA score >/=3(%)	P value
Daele EV *et al.*[13]	2016	3. 59%	>0.05
Jina A *et al.*[6]	2019	44.44%	<0.05
Kryzauskas M *et al.*[7]	2020	12.68%	<0.05

Present study	2021	15. 15%	>0.05(0.013)

In our study, 33.33% patients with anastomotic leak in this study had a history of steroid use which strongly correlates with the study done by Daele EV *et al.* in which it was 33%. Jina A *et al.* reported a higher incidence while Eriksen TF *et al*., reported a much lower incidence in their studies as shown in *Table 20.*

Table 20: Association of steroids with anastomotic leak

Study	Year	Steroids (%)	P value
Eriksen TF *et al.*[14]	2014	6.77%	<0.05
Daele EV *et al.*[13]	2016	33%	<0.05
Jina A *et al.*[6]	2019	66.66%	<0.05
Present study	2021	33.33%	<0.05 (0.009)

In our study 16.67% patients had an associated comorbidity which strongly correlates with study done by Jina A *et al.*where it was found to be 16.66% while Daele EV *et al.* reported this number as 25% as shown in *Table 21.*

Table 21: Association of comorbidity with anastomotic leak

Study	Year	Comorbidity(%)	P value
Daele EV et al[13]	2016	25%	>0.05
Jina A et al[6]	2019	16.66%	>0.05
Present study	2021	16.67%	<0.05(0.008)

In our study 8.7% patients with anastomotic leak had an emergency surgery which correlates with the study done by Damen N *et al*. where it was found to be 7%. Jina A *et al*. reported a 17.6% association while Kshirsagar AY *et al*. reported an association of 23.25% as shown in *Table 22.*

Table 22: Association of emergency surgery with anastomotic leak

Study	Year	Emergency surgery (%)	P Value
Damen N *et al.*[15]	2014	7%	<0.05
Jina A *et al.*[6]	2019	17. 59%	>0.05
Kshirsagar AY *et al.*[5]	2020	23.25%	<0.05
Present study	2021	8.7%	>0.05(0.615)

In our study the association of sepsis with anastomotic leak was found to be 50% correlating with the study done by Jina A *et al*., where it was found to be 56% as seen in *Table 23.*

Table 23: Association of sepsis with anastomotic leak

Study	Year	Sepsis(%)	P value
Jina A *et al.*[6]	2019	56%	<0.05
Farghaly AE *et al.*[10]	2019	69.2	<0.05
Kshirsagar AY *et al.*[5]	2020	37. 5%	<0.05
Present study	2021	50%	<0.05(0.002)

In our study the association of duration of surgery (>180 mins) with anastomotic leak was found to be 42.86% correlating with the study done by Jina A *et al*. where it was found to be 38.09% while Telem DA *et al.* reported their number as 54% as shown in *Table 24.*

Table 24: Association of duration of surgery with anastomotic leak

Study	Year	Duration of surgery (%)	P value
Telem DA *et al.*[11]	2010	54%	<0.05
Jina A *et al.*[6]	2019	38.09%	<0.05
Present study	2021	42.86%	<0.05

In our study the association of blood transfusion (>2 units) with anastomotic leak was found to be 30.77% correlating with the study done by Jina A *et al.* where it was found to be 33.33% as seen in *Table 25.*

Table 25: Association of blood transfusion with anastomotic leak

Study	Year	Percentage association	P value
Telem DA *et al.*[11]	2010	50%	<0.05
Jina A *et al.* [6]	2019	33.33%	<0.05
Present study	2021	30.77%	<0.05(0.002)

In our study, vasopressor use was associated with anastomotic leak in 33.33%. Our reported numbers are consistent with studies done by Telem DA *et al.* which reported their number as 29.62% and Zakirson T *et al.* reported their association as 37.87% as shown in *Table 26.*

Table 26: Association of vasopressors with anastomotic leak

Study	Year	Percentage association	P value
Telem DA *et al.*[11]	2010	29.62%	<0.05
Zakirson T *et al.*[16]	2017	37.87%	<0.05
Present study	2021	33.33%	<0.05(0.039)

CONCLUSION:

Bowel anastomosis is one of the commonest surgical procedures done to establish a connection between two portions of the bowel. It is a common procedure done in both elective and emergency settings. The technique depends on various factors such as site, quality of bowel, underlying disease process etc. It is indicated in various conditions such as gangrene of the bowel, infections, benign and malignant conditions, trauma, inflammatory bowel disease.

Despite taking adequate care, few complications can occur, most importantly anastomotic leak which is the core of this study.

This study is aimed at studying the risk factors associated with anastomotic leakage and the measures by which this complication can be reduced by early diagnosis (radiologically, endoscopically and intraoperatively) and corrections of various modifiable risk factors. Various risk factors like smoking, anemia, emergency surgeries, presence of sepsis etc. were seen to contribute to a higher incidence of anastomotic leaks (5.88%).

Further, risk factors such as hypoalbuminemia, use of >2 blood transfusions and presence of comorbidity also played a significant role in causing higher rates of anastomotic leaks in patients with these risk factors.
Comorbidities like diabetes, tuberculosis, bronchial asthma were also seen to act as risk factors for anastomotic leaks in this study. Patients in whom corticosteroids/ radiotherapy earlier were used were also more prone to develop anastomotic leak.

Based on our study, it is emphasized that it is of utmost importance to identify these risk factors having a strong association with anastomotic leak and plan the line of management to prevent and reduce the rate of anastomotic leaks seen in day to day surgical practice and provide a hassle free postoperative care for patients undergoing gastrointestinal surgeries.

Ethical Approval:
As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

Consent
As per international standard or university standard, patient(s) written consent has been collected and preserved by the author(s).

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