Original Research Article

Short term outcome of extracorporeal and Intracorporeal anastomosis in laparoscopic colorectal surgeries – A prospective observational study.

Abstract

Background

Laparoscopic colorectal surgery has gained popularity around the Globe. There are series of randomized prospective clinical trials confirming that the oncological outcomes of laparoscopic colectomies are equivalent to those of open surgery. Laparoscopic colectomy significantly improves the short term outcomes of patients such as lower pain scores, less estimated blood loss and shorter hospital stay. There is a long term benefit of laparoscopy too with respect to reduced rates of incisional hernias. The bowel anastomosis after laparoscopic resection of the tumour can be done in two ways - extracorporeal anastomosis and Intracorporeal anastomosis. Our study observed and evaluated the data of the patients who underwent these two techniques.

Materials and Methods

A prospective observational study was conducted in the department of General Surgery, SMHS hospital of Government Medical College, Srinagar. A total of 32 patients were studied out of which 20 patients had undergone intracorporeal anastomosis and 12 patients had undergone extracorporeal anastomosis. The aims of the study were to assess the operative time, post-operative ileus, length of hospital stay, anastomotic leak and other anastomotic complications,wound infections and extraction site hernias.

Results

The patients in our study were in the range of 30-85 years with a mean age of 59.18 $\pm$ 14.92. and 59.4% of patients were males and the rest 40.6% were females, with male/female ratio of 1.46:1. There was no significant difference in mean operative time between the intracorporeal group and extracorporeal group (188$\pm$9.78 minutes vs.180.3$\pm$13.8 minutes). The patients in the intracorporeal group had earlier return of bowel function than extracorporeal group as reflected by earlier appreciation of flatus (median of 2.0 days vs. 3.0 days)and tolerance to orals (median of 3 days vs. 4 days).This had led to the shorter hospital stay of the intracorporeal group than the extracorporeal group of patients (median of 5 days vs. 6.5 days) The wound infection rate was 6.3 percent in our study, 5.0% in the intracorporeal group and 8.3% in the extracorporeal group. Only 1 out of the total 32 patients (3.1%) developed mesenteric twist which belonged to the extracorporeal group (1 out of 12 patients). We did not observe any leak in both the groups of patients in the study. No patient in our study in either group developed extraction site or incisional hernia.

Conclusion

Intracorporeal anastomosis in laparoscopic colorectal surgeries leads to earlier return of bowel function, earlier resumption of orals and shorter hospital stay than the extracorporeal anastomosis. There does not exist a significant difference between the two modes of anastomosis in terms of anastomotic and wound related complications.

Keywords; laparoscopy, colon, rectum, anastomosis, techniques

Introduction

Colon cancer is the most common type of gastro intestinal cancer [1].Chemotherapy and radiotherapy can improve survival in colorectal cancer patients. However, the only treatment with curative intent is surgical resection of the tumor. Colectomy for cancer can be performed using either open or laparoscopic approach. Laparoscopic colorectal resection has gone through a major evolution since 1991, when the first reports of colorectal resections had been published [2, 3, 4].Laparoscopic techniques of colon resection involve laparoscopic mobilization of the diseased colonic segments. Various techniques of laparoscopic colonic resection are:

1. Laparoscopic assisted colectomy (LAC) with extra corporeal anastomosis.
2. Laparoscopic colectomy with intra corporeal anastomosis (LCIA).
3. Hand assisted colectomy (HAC or HALS)

In 1991, Jacobs [5] performed the first laparoscopic right hemicolectomy. After right hemicolectomy the ileocolic anastomosis cannot be fashioned "in a natural way" as it normally happens following left hemicolectomy or anterior resection of the rectum; for this reason, different kinds of laparoscopic right colectomy have been proposed [6]. The ileocolic anastomosis can be performed using different techniques and devices depending on the intracorporeal and extracorporeal approach; sometimes even using combination of different techniques. The two main anastomotic techniques are: the anti-/isoperistaltic latero-lateral ileocolic anastomosis, which consists of at least a 5 cm latero-lateral anastomosis performed with a laparoscopic or conventional linear stapler [7]. This anastomosis can also be manually performed; despite the lower cost, this requires a greater ability [8,9]. The end-to-end ileocolic anastomosis is performed using a biofragmentable anastomosis ring [10] or hand-sewn suturing. Since the publication of the first laparoscopic colectomy its use has been increased.[11] Moreover, randomized trials have demonstrated that laparoscopic surgery for colon cancer achieves good short-term and oncologic outcomes similar to those found in open surgery.[12,13] However, laparoscopic surgery for transverse and descending colon cancer requires an advanced technique. Hence, only recently, studies have demonstrated the feasibility and safety of the laparoscopic resection for lesions located in the distal transverse and descending colon.[14,15]Moreover, the ileocolic anastomosis is probably safer than the colo-colic anastomosis. The relatively poor vascularization status in the distal transverse colon (the Griffiths' point) is believed to add an increased risk of anastomotic complications.[16] Incisional hernias after open surgery occur in 12 to 20% and may lead to significant morbidity. Midline extraction sites have a higher chance of hernias than non-

midline.[17] Laparoscopic surgery for rectal cancer has been considered technically more demanding when compared with that for colon cancer. However, laparoscopic total mesorectal excision (TME) has been positively employed for the treatment of rectal cancer in Japanese Centres without lateral lymph node metastasis [18] or invasion to the adjacent organ, since it has the advantage of providing a good view even in a narrow pelvis and allowing to perform more precise autonomic nerve preservation

Rectal transection and anastomosis at the lower rectum is the most challenging part of laparoscopic low anterior resection. Therefore, some have demonstrated that rectal transection should be performed using instruments for open surgery with small laparotomy. In our institute, however, rectal transection using a currently available endo-stapler followed by anastomosis with a double stapling technique is usually performed.However, anastomotic leakage is still a serious problem after sphincter-saving surgery for rectal cancer.[19] Diverting stomata are used to reduce leakage-related complications after LAR, but the routine use of diverting stomata is controversial because of reported morbidity associated with their creation and closure.[20,21] Many authors believe that patients treated with total mesorectal excision (TME) and neoadjuvant chemoradiotherapy (NCRT) require a diverting stoma after open LAR.[22,23,24] At the same time, there is a tendency for the creation of a diverting stoma in sphincter-saving laparoscopic rectal cancer surgery. A diverting stoma is often created to minimise the impact of pelvic sepsis from an anastomotic dehiscence following coloanal or colorectal anastomosis.[21,22,25] A temporary colostomy or ileostomy is created for decompression of colorectal anastomosis as a diverting stoma. No prospective studies have reported that colostomy as a diverting stoma is better than ileostomy or vice versa. Diverting colostomy causes a higher rate of stoma complications such as infection and stoma prolapse. However, ileostomy tended to cause more post-closure surgical complications.[26,27] We prefer the creation of loop ileostomies in our clinical practice.

Aims and objectives

The aim of this study was to assess the short-term outcome of extracorporeal anastomosis and intracorporeal anastomosis in laparoscopic colorectal surgeries in terms of; operative time, anastomotic leak rates and other complications of anastomosis, Post-operative ileus, Length of hospital stay,Wound infections.Extraction and port site hernias.

Material and methods:

This prospective observational study was conducted in the department of General and minimal access Surgery, from 2015 to 2018 after obtaining the clearance from the Institutional Ethical Committee. A total of 32 cases were enrolled in the study. This comprised of patients admitted for elective surgery for right colon growth, transverse colon growth, left colon growth, sigmoid colon growth and rectal growth above peritoneal reflection in various surgical wards of hospital. The patients that are included in the study are;

1. Age >18 years.
2. Patients who are eligible for curative resection of cancer by means of hemicolectomy.
3. In case of polyp, a colonoscopic biopsy proven invasive cancer.
4. For rectosigmoid, patient can be included if the tumour lies above the peritoneal reflection.

5. Solitary colon carcinoma observed at colonoscopy or barium study.

The patients that are excluded from the study are;

1. Contraindications to general anaesthesia e.g. congestive heart failure, chronic renal failure, chronic obstructive lung disease, un-correctable coagulopathy
2. General contradictions to laparoscopic surgery.
3. Metastases in the liver or lungs or pre operative evidence of involvement of adjacent structures as detected by CT, MRI or USG.
4. Acute intestinal obstruction.
5. Patients who had conversion to open procedure will be excluded from the analysis.

These patients were initially evaluated in the outpatient department (OPD) and then planned for surgery. On admission, a detailed history of the patient was recorded including the presenting complaints, duration of the complaints, past history especially with reference to previous surgery, family history and any other associated condition such as chronic ailment and any drug intake.

General physical examination was done with particular consideration of build, height and weight followed by systemic examination. Thorough abdominal examination was done in each patient. The patients were taken for laparoscopic colorectal surgery after proper clinical evaluation and after diagnosing them with the disease on colonoscopy and after confirming malignancy on colonoscopic biopsy**.** Each patient and his attendants were fully explained about the nature of the procedure and the possible complications inherent to the procedure in the native language and thereafter a written consent was sought from the patient prior to surgery. All base line investigations were performed which includes (Complete blood count, Coagulogram, Liver function test, Kidney function test, Blood sugars, Serum electrolytes (Na^+/K^+).Chest X-ray and abdominal USG were also performed to investigate lung and liver metastasis respectively. Pre-operative CECT abdomen was done in all patients as a pre-operative staging. The Serum Carcinoembryonic antigen (CEA) also done in all patients.

Pre-operative preparation

After completing the routine and specific investigations, patients were assessed for anesthetic fitness to undergo the laparoscopic surgery. Patients were properly build up for the surgery. Pre-operative haemoglobin of more than 10 g/dl and albumin level more than 3.5 g/dl were considered the standard pre-requisites as these might otherwise become the confounding factors influencing the bowel anastomosis. All the patients were kept fasting 12 hours before surgery and a proper bowel preparation was done using oral solution of polyethylene glycol. Serum electrolytes were repeated before surgery and necessary corrections were made. Ceftriaxone 1 gm I.V as surgical prophylaxis was given to every patient before surgery. Thromboembolic prophylaxis was only given to high risk patients and not considered necessary in all patients as the protocol of enhanced recovery (ERAS) was followed

Planning the Approach

Pre-operative cross-sectional imaging (CECT abdomen) was considered a standard to determine the operability; still a diagnostic laparoscopy was performed in all the patients to look for a

missed metastatic deposit on the liver surfaces and to determine the resectability of the tumour. Patients were allotted to either extracorporeal or intracorporeal limb based on CT scan and intraoperative findings.

OPERATIVE TECHNIQUE:

Trocar placement

The experience gained in basic laparoscopy, like technique of creation of pneumoperitoneum, trocar insertion and dissection techniques forms the foundation for advanced laparoscopic colorectal surgery. Pneumoperitoneum is created either via the percutaneous insertion of a Verres needle or with the open Hassan technique. Trocar placement is a crucial part of surgery.

In LRHC, we used four ports: a 10 mm to 12 mm camera port for a 30^{o} laparoscope positioned at the level of umbilicus on left side of abdomen, one 12-mm working port for stapling devices in the left upper abdomen above the camera port and 2 five-mm working ports, one located in the left lower abdomen below the camera port and another in the right lower abdomen. The 5 mm port located in the right lower abdomen is later extended for extraction of the specimen. In LLHC, four port technique was also followed but port positions were mirror images of LRHC. Four ports were also used in cases of sigmoidectomy, anterior resection and low anterior resection, with 10 mm umblical port for camera, 12 mm working port in right lower abdomen and two 5 mm ports – one to the left of camera port and another in the left lower abdomen. The port located in the left lower abdomen is later extended for extraction of the specimen.

Basic common steps in laparoscopic colorectal resection

All laparoscopic colon procedures have several steps that are common. These steps include:

1. Localization of the lesion / tumour.
2. Mobilization of the lesion (medial-to-lateral approach).
3. Vessel ligation for devascularization of the specimen.
4. Bowel division.
5. Restoring bowel continuity by Anastomosis (extracorporeal or intracorporeal).
6. Specimen retrieval and protection of the wound during retrieval.

Localization of the lesion

Once the trocars have been placed, the abdomen should be inspected thoroughly and the lesion has to be identified. At times there is difficulty in localizing the region in the large bowel. This is mainly due to loss of tactile sensation. Prior localization of the anatomical portion and the quadrant with barium enema and colonoscopy helps in locating the lesion easily. Lesions can be marked with India ink during colonoscopy so that the tattooing can be seen during laparoscopy. Circumferential injection of the dye (preferably on three sites) is necessary to localize the lesion. We used to perform the diagnostic laparoscopy and do the formal MNT staging of the tumour. Large tumours could be easily located but small tumours were located by performing the bowel walk and corelating with the colonoscopic and CT findings. Sigmoid and rectal tumours were located using On-Table sigmoidoscopy.

Mobilization of the lesion

Medial mobilization of the colon was done before lateral mobilization because this was technically feasible and allowed early devascularization of the specimen before tumour handling. This has been seen to reduce the spread of the tumour by decreasing tumour embolization.

Vessel ligation

During medial mobilization, vessels supplying the segment of the colon to be resected were ligated and cut at the origin taking due care to follow the oncological principles.

Bowel division

After complete mobilization from both medial and lateral sides of the segment to be resected, the division of the bowel was performed using 45 mm or 60 mm Endo GIA stapler. Complete haemostasis at the site of division was ensured and over running sutures using vicryl was given if required for haemostasis.

Bowel Anastomosis and specimen retrieval

There are two techniques used for creation of bowel anastomosis- Extracorporeal anastomosis and Intracorporeal anastomosis. In extracorporeal anastomosis, the first three steps i.e. localization of the lesion, mobilization of the lesion and vessel ligation are done intracorporeally and then the colon is exteriorized through 4cm to 7cm incision extended from the umbilical port. The tumor is then resected with clear margins and bowel continuity restored with side-to-side stapled closure or double-layer hand sewen closure. In intra corporeal anastomosis, all the steps are carried out inside the body including bowel division and anastomosis. Once the lesion is identified and the colon mobilized completely, vascular control is achieved intra corporeally by division of vascular pedicles or by use of hemoclips. The tumor is resected, and anastomosis fashioned intracorporeally using the 45 mm or 60mm Endo GIA stapler. The tumor specimen is retrieved through a small incision 3-5 cm in length extended from 5 mm port located on the lower abdomen. The specimen is always opened on the side table to ensure that the tumor is included in the resection. Figure 1-5.In all cases strict postoperative care was ensured.

Follow up:

After discharging from the hospital, the patients were advised to follow in OPD with the histopathology of the resected specimen. Patients with stage 1 disease did not require adjuvant chemotherapy and on further follow up such patients were advised serum CEA levels every three months. Such patients were advised CT scan only if there was rise in serum CEA levels. Patients with stage 2 disease and above were strictly advised to follow the medical oncology for chemotherapy. Serum CEA levels were repeated every three months and an annual CT scan and colonoscopy were advised to look for recurrence of the disease.

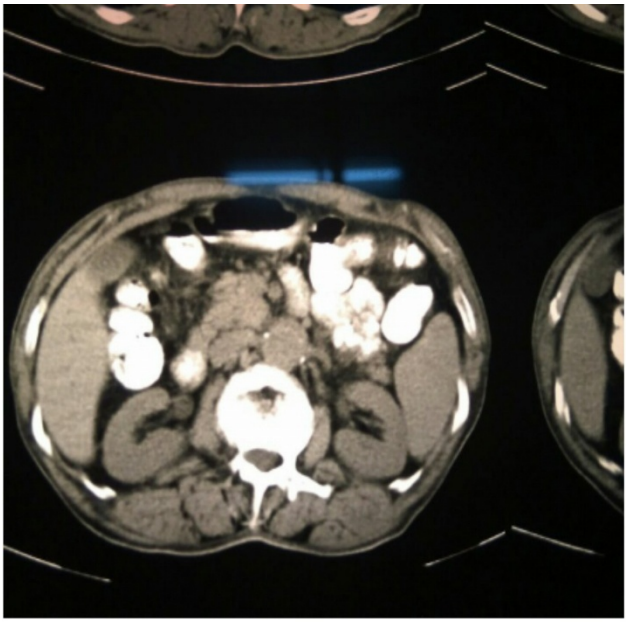

Fig.1CECT showing Right colonic growth

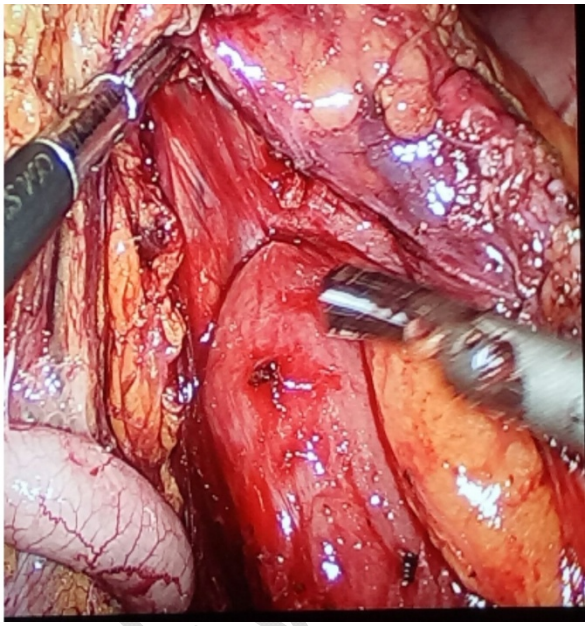

Fig. 2 Mobilization of Right colon

Fig.3 and 4 Creation of extracorporeal and in tra corporeal anastomosis

Fig 5 specimen of colon with ileum

Fig.6 Port position in right hemicolectomy

Fig.7 port operative scar in right hemicolectomy

Fig.8 Port position in LAR

Statistical Analysis

The recorded data was compiled and entered on a spread sheet (Microsoft excel) and then exported to data editor of SPSS V.20.0 (SPSS Inc., Chicago, Iclinos, USA).Continuous variables were summarized in the form of means and standard deviations whereas categorical variables were summarized as median and percentage. Results were compared using Chi square tests and Mann-Whitney U-tests. P-values less than 0.05 were considered to be statistically significant. Graphically the data was presented by Bar Charts and Pie Charts.

Data Analysis:

The study included 32 patients out of which 20 patients had undergone intra-corporeal anastomosis and 12 patients had undergone extra-corporeal anastomosis after resection of tumour. The patients in our study were in the range of 30-85 years with a mean age of 59.18 $\pm$ 14.92. Maximum number of patients were in the age group of 41-60 years (43.75%) followed by patients older than 60 years (40.63%). Table 2 shows distribution of patients according to their gender. 59.4% of patients were male and the rest 40.6% were females with male/female ratio of 1.46: 1. The demographic data is shown in table 1 and 2.

Tabe1: Age distribution of study patients

Age (years)		Anastomosis		Total
		Intracorporeal	Extracorporeal	
<40	Count(Percentage)	4(12.50 %)	1(3.12 %)	5(15.62 %)
41-60	Count(Percentage)	9(28.12%)	5(15.63 %)	14(43.75 %)
>60	Count(Percentage)	7(21.88%)	6(18.75%)	13(40.63 %)
Total	Count(Percentage)	20(62.50%)	12(37.50 %)	32(100.0 %)

Mean$\pm SD = 59.18 \pm 14.92$,

Table 2: Gender distribution of study patients**.**

Sex		Anastomosis		Total
		Intracorporeal	Extracorporeal	
M	Count(Percentage)	13(40.62%)	6(18.75%)	19(59.37 %)
F	Count(Percentage)	7(27.88 %)	6(18.75 %)	13(18.75 %)
Total	Count(Percentage)	20(100.0%)	12(100.0%)	32(100.0%)

Table 3 shows operation time in the two groups of study patients with the mean operation time of 188.1$\pm$9.78 minutes in the intracorporeal group and 180.3$\pm$ 13.8 minutes in the extracorporeal group. No significant difference in the operation time between the two groups of study population could be observed as reflected by the p-value of 0.075

Table: 3 Operation time (minutes) in two techniques of study patients.

Anastomosis	Number of Patients	Operation time		p-value
		Mean	Std. Deviation	
Intracorporeal	20	188.1	9.78	0.075
Extracorporeal	12	180.3	13.85	

Table 4 shows absolute and percentage distribution of patients in the two groups of study with respect to the appreciation of passage of flatus. Patients in the intracorporeal group had the

median of 2.0 days where as patients in the extracorporeal group had median of 3.0 days. The difference in the two groups is statistically significant as shown by p-value of 0.007

Table 4: Time distribution (days) of appreciation of passage of flatus in the two groups of study patients

Flatus		Anastomosis		Total
		Intracorporeal	Extracorporeal	
1	Count(percentage)	1(5.0%)	1(8.3%)	2(6.3%)
2	Count(percentage)	12(60.0%)	1(8.3%)	13(40.6%)
3	Count(Percentage)	6(30.0%)	5(41.7%)	11(34.4%)
4	Count(Percentage)	1(5.0%)	4(33.3%)	5(15.6%)
5	Count(Percentage	0(0.0%)	1(8.3%)	1(3.1%)
Total	Count(Percentage	20(100.0%)	12(100.0%)	32(100.0%)
	Median	2.0	3.0	-
p=0.007, Mann-Whitney test				

Table 5 shows absolute and percentage distribution of patients in the two groups of study with respect to the first bowel movement. Patients in the intracorporeal group had the median of 4.0 days where as patients in the extracorporeal group had median of 5.0 days. The difference in the two groups is statistically significant as shown by p-value of 0.005

Table 5: Time distribution (days) of bowel movement in the two groups of patients in study.

Stools		Anastomosis		Total
		Intracorporeal	Extracorporeal	
2	Count(Percentage)	2(10.0%)	0(0.0%)	2(6.3%)
3	Count(Percentage)	2(10.0%)	1(8.3%)	3(9.4%)
4	Count(Percentage)	12(60.0%)	1(8.3%)	13(40.6%)
5	Count(Percentage)	2(10.0%)	7(58.3%)	9(28.1%)
6	Count(Percentage)	2(10.0%)	3(25.0%)	5(15.6%)
Total	Count(Percentage)	20(100.0%)	12(100.0%)	32(100.0%)
Median		4.0	5.0	-
p=0.005, Mann-Whitney test				

Table 6 shows absolute and percentage distribution of the two groups of study population with respect to the day of tolerance of orals. In the intracorporeal group, 45% patients tolerated orals on day 2, another 45% patients on day 3 and 5% patients on day 4 and day 5 with the median of 3 days.While, in the extracorporeal group 33.3% patients tolerated orals on day 3, 50% patients on day 4 and 16.7% patients on day 5 with the median of 4 days. There is a statistically significant difference between the two groups with respect to the day of oral tolerance as reflected by the p-value of 0.001.

Table 6: Time distribution (days) of oral tolerance in two techniques of anastomosis in study patients.

Orals		Anastomosis		Total
		Intracorporeal	Extracorporeal	
2	Count(Percentage	9(45.0%)	0(0.0%)	9(28.1%)
3	Count(Percentage	9(45.0%)	4(33.3%)	13(40.6%)
4	Count(Percentage	1(5.0%)	6(50.0%)	7(21.9%)
5	Count(Percentage	1(5.0%)	2(16.7%)	3(9.4%)
Total	Count(Percentage	20(100.0%)	12(100.0%)	32(100.0%)
Median		3.0	4.0	-
p=0.001, Mann-Whitney test				

Table 7 lists different complications of laparoscopic colorectal surgeries reported in literature and their incidence in our study. We did not observe any anastomotic leak or extraction site hernia in our study. Anastomotic twist is described in Table 8 and wound infection in Table 9 in detail.

Table 7: Rate of Complications in two groups of study patients

Complication		Intracorporeal	Extracorporeal	Total
Anastomotic leak	Count(Percentage	0(0%)	0(0%)	0(0%)
Anastomotic twist	Count(Percentage	0(0%)	1(8.3%)	1(3.12%)
Wound infection	Count(Percentage	1(5%)	1(8.3%)	2(6.3%)
Extraction site hernia	Count(Percentage	0(0%)	0(0%)	0(0%)

Table 8 shows absolute and percentage distribution of mesenteric twist at site 0f anastomosis in the study patients. Only 1 out of the total 32 patients (3.12%) developed mesenteric twist which belonged to the extracorporeal group (1 out of 12 patients). No patient in the intracorporeal group developed this complication. But the difference between the two groups was statistically insignificant as reflected by the p-value of 0.375

Table 8: Rate of mesenteric twist in two techniques of anastomosis in study patients.

Anastomosis	Number of Patients	Mesentric twist	Percentage
Intracorporeal	20	0	0 %
Extracorporeal	12	1	8.3 %
Total	32	1	3.12 %
p>0.375, Chi-square test Exact p			

Table 9 shows rate of wound infection in the two groups of study population. In the intracorporeal group 1 out of 20 patients (5.0%) developed wound infection while as in the extracorporeal group 1 out of 12 patients (8.3%) developed wound infection. The difference in the rate of wound infection was statistically insignificant (p-value> 0.999). Overall, the wound infection rate was 6.3 percent.

Table 9: Rate of wound infection in two groups of patients in study

Anastomosis	Number of Patients	Wound Infection	Percentage
Intracorporeal	20	1	5 %

Extracorporeal	12	1	8.3 %
Total	32	2	6.3 %
p>0.999, Chi-square test Exact p			

Table 10 shows the absolute and percentage distribution of the patients in the two groups of the study patients with respect to the number of days of hospital stay. Most of the patients in the intracorporeal group (70%) stayed in the hospital for 5 – 6 days while as in the extracorporeal group majority of the patients (75%) stayed in the hospital for 6 – 7 days. Intracorporeal group had the median hospital stay of 5.0 days where as the extracorporeal group had the median hospital stay of 6.5 days with the p-value of 0.010 signifying statistically significant difference.

Table 10: length of hospital stay(days) in two groups of study patients

LOHS		Anastomosis		Total
		Intracorporeal	Extracorporeal	
4	Count(Percentage	2(10.0%)	0(0.0%)	2(6.3%)
5	Count(Percentage	9(45.0%)	1(8.3%)	10(31.3%)
6	Count(Percentage	5(25.0%)	5(41.7%)	10(31.3%)
7	Count(Percentage	3(15.0%)	4(33.3%)	7(21.9%)
8	Count(Percentage	1(5.0%)	1(8.3%)	2(6.3%)
10	Count(Percentage	0(0.0%)	1(8.3%)	1(3.1%)
Total	Count(Percentage	20(100.0%)	12(100.0%)	32(100.0%)
Median		5.0	6.5	-
p=0.010, Mann-Whitney test				

Discussion

Application of laparoscopy to colorectal surgery has produced some short- term benefits like faster return of gut function leading to more rapid discharge from the hospital and a faster return to normal activity as well as long term benefits like reduced rates of obstruction secondary to adhesions and reduced incidence of ventral hernia. The creation of bowel anastomosis after laparoscopic resection of large bowel tumour can be done in two ways – extracorporeal anastomosis and intracorporeal anastomosis. A number of studies have been carried worldwide to document the equalities and differences between the two modes of creation of bowel anastomosis with respect to the short- term outcomes like – operation time, post-operative return of bowel function, complications of anastomosis, wound infection and length of hospital stay. So, we also have conducted a study to evaluate these short-term outcomes of extracorporeal and intracorporeal anastomosis in laparoscopic colorectal surgeries. It was a hospital based prospective observational study conducted in the department of General and minimal access Surgery of the hospital of Government Medical College.

A total of 32 patients were studied out of which 20 patients had undergone IC anastomosis and 12 patients had undergone EC anastomosis. The results were based on age, gender, operative time, post-operative return of bowel function in terms of appreciation of flatus, oral tolerance and first bowel movement, complications such as anastomotic leak, mesenteric twist, wound

infections and extraction site hernias and length of hospital stay. The patients in our study were in the range of 30-85 years with a mean age of 59.18 ± 14.92. Maximum number of patients were in the age group of 41-60 years (43.8%) followed by patients older than 60 years(40.6%).Jorge Arredondo Chaves, Carlos Pastor Idoate et al[28] have reported in their study mean age group of patients as 62.6±13.4 years in the intracorporeal group and 58.9±12.9 years in the extracorporeal group which closely matched with our study. Minia Hellen, Casandra Anderson et al [29] reported median age of patients as 69 and 67 years in the intracorporeal and extracorporeal groups respectively. Ashley S. Vergis, Sarah N. Steigerwald et al [30] had the mean age group in the two groups of their study as 65 and 69 years. Both these studies had average age of the patients comparable with our study. In our study, 59.4% of patients were male and the rest 40.6% were females with male/female ratio of 1.46:1. Jorge Arredondo Chaves, Carlos Pastor Idoate et al have reported male/female ratio of 1.22:1 and Tu Jian-Cheng, BSc, Wang Shu-Sheng, BSc et al [31] reported male/female ratio of 1.57:1. Both of these studies had comparable gender ratio with our study.

In our study there was no significant difference in operative time between two groups.The mean operation time in the intracorporeal group was 188±9.78 minutes and 180.3±13.8 minutes in the extra corporeal group. Comparable results were obtained by Minia Hellen, Casandra Anderson et alwho reported the mean operative time of 190 minutes in the intracorporeal group and 180 minutes in the extracorporeal group.Anania G, Santini M et al [32] also showed similar results with the mean operative time of 186.8 minutes in the intracorporeal group and 184.8 minutes in the extracorporeal group.

The appreciation of flatus in the intracorporeal group had the median of 2.0 days where as patients in the extracorporeal group had median of 3.0 days. The difference in the two groups is statistically significant as shown by p-value of 0.007. Comparable results were obtained by Jayleen Grams, Winnie Tong et al[33],Anania G, Santini M et al who reported mean days of appreciation of flatus in the intracorporeal group as 2.0 days and 2.4 days in the extracorporeal group.Tu Jian-Cheng, BSc, Wang Shu-Sheng, BSc et al reported the mean duration of appreciation of flatus as 2.57±0.08 days in the intracorporeal group and 3.10±0.11days in the extracorporeal group which are comparable to our study.

The first bowel movement in the intracorporeal group had the median of 4.0 days where as patients in the extracorporeal group had median of 5.0 days. The difference in the two groups is statistically significant as shown by p-value of 0.005.Jorge Arredondo Chaves, Carlos Pastor Idoate et al in 2011 reported the median days of the first bowel movement as 3 days in the intracorporeal group 4 days in the extracorporeal group. Anania G, Santini Met al in 2012reported mean of 3.8 days in the intracorporeal group and 4.9 days in the extracorporeal group for the first bowel movement. In our study patients in the intracorporeal group had the median of 4.0 days where as patients in the extracorporeal group had median of 5.0 days for the first bowel movement. The difference in the two groups is statistically significant as shown by p-value of 0.005. Our results were comparable with the literature.

In our study, in the intracorporeal group, 45% patients tolerated orals on day 2, another 45% patients on day 3 and 5% patients on day 4 and day 5 with the median of 3 days. While, in the extracorporeal group 33.3% patients tolerated orals on day 3, 50% patients on day 4 and 16.7% patients on day 5 with the median of 4 days. There is a statistically significant difference between the two groups with respect to the day of oral tolerance as reflected by the p-value of 0.001. Our results were comparable to those mentioned in the literature.

Anania G, Santini M et al reported the mean of 3.5 days and 4.5 days for the resumption of liquid diet in the intracorporeal and extracorporeal groups respectively. The mean duration for tolerance to solid diet in the two groups was 4.6 days and 5.7 days respectively. Ashley.Vergis, Sarah N. Steigerwaldet al reported mean of 2.43 days and 3.21 days for tolerance to solid orals in the intracorporeal and extracorporeal groups respectively.

In our study we did not observe any leak in both the groups of patients in study.Tu Jian-Cheng, BSc, Wang Shu-Sheng, BSc et al alsoreported zero leak rates in both the groups. Jayleen Grams, Winnie Tong et al have reported zero leak rate in the intracorporeal group but 1 out of 51 cases (1.96%) in the extracorporeal group had anastomoticleak. However studies conducted by Minia Hellen, Casandra Anderson et al and Milone M, Elmore U et al[34] showed leak rates of 4.3% and 4.19% in the intracorporeal group respectively and 5.3% in the extracorporeal group each. Significant leak rates in these studies could be due to the larger study design in these studies.

In our study,Only 1 out of the total 32 patients (3.1%) developed mesenteric twist which belonged to the extracorporeal group (1 out of 12 patients). No patient in the intracorporeal group developed this complication. But the difference between the two groups was statistically insignificant as reflected by the p-value of 0.375. The patient who developed this complication had hepatic flexure growth and had undergone extended right hemicolectomy. He presented in the postoperative period with features of sub-acute intestinal obstruction (small bowel obstruction) and was re-explored.Minia Hellen, Casandra Andersonet al have reported 1 out of 23 patients in the extracorporeal group to develop mesenteric twist. Jorge Arredondo Chaves, Carlos Pastor Idoate et al reported 1 out of 25 patients and Anania G, Santini M et al reported1 out of 33 patients of extracorporeal group to develop this complication.

In this study, in the intracorporeal group 1 out of 20 patients (5.0%) developed wound infection while as in the extracorporeal group 1 out of 12 patients (8.3%) developed wound infection. The difference in the rate of wound infection was statistically insignificant (p-value> 0.999). Overall, the wound infection rate was 6.3 percent. Milone M, Elmore U et al. reported overall wound infection rate of 6.83%, 3.84% wound infection rate in intracorporeal anastomosis and 10.6% wound infection rate in extracorporeal anastomosis comparable with our study. Jorge Arredondo Chaves, Carlos Pastor Idoate et al. reported rate of wound infection rate of 8% in the extra corporeal group comparable with our study but slightly lower rate in the intracorporeal group(2.86%) with the overall wound infection rate of 5% which was comparable to our study. Ron Shapiro, Uri Keler, et al[35] also reported wound infection rate of 4.4% in the intracorporeal anastomosis close to our observation.

No patient in our study in either group developed extraction site or incisional hernia. Studies carried by Jayleen Grams,et al,Anania et al in 2012, and Milone et al also did not report any extraction site or incisional hernia in their studies.However studies carried by Jorge Arredondo Chaves et al, Shapiro et al reported incisional hernia in few patients. Among all the studies, only Shapiro et al[36] have recorded a significant percentage of patients in the extracorporeal group to develop incisional hernia. In the study 2.2% patients in the intracorporeal group developed incisional hernia while as 17% in the extracorporeal group developed this complication.

In our study, the Intra-corporeal group had the median hospital stay of 5.0 days where as the extracorporeal group had the median hospital stay of 6.5 days with the p-value of 0.010 signifying statistically significant difference.Jorge Arredondo Chaves, Carlos Pastor Idoate et al reported average hospital stay of 6 days in the intracorporeal group and 8 days in the extracorporeal group. Roberto Cirocchi, Stefano Trastulli et al[37] reported average hospital stay of 4 days in the intracorporeal group and 5 days in the extracorporeal group. Ron Shapiro, Uri

Keler, et al has reported mean hospital stay of 5.9±2.1 days in the intracorporeal group and 6.9± 3.0 days in the extracorporeal group. The results of all these studies were comparable with our study

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