Preservation or nonpreservation of left colic artery in rectal and sigmoid cancer surgery

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Background
It is unclear whether to preserve the left colic artery (LCA) for sigmoidectomy or not in cancer surgery. The objective of this study was to assess the value of preservation of LCA in sigmoidectomy in cancer surgery.
Patients and methods
A total of 55 patients with rectal and sigmoid cancer were admitted to the Menoufia University Hospital (General Surgery Department) and Al-Azhar University Hospital (General Surgery Department). Patients were randomized into two groups: group A included nonpreservation of LCA (28 patients), and group B included preservation of LCA (27 patients). Our oncologic considerations were the number of apical lymph nodes, overall recurrence, 1-year overall survival (disease-free survival), 30-day postoperative morbidity, 30-day postoperative mortality, anastomotic leakage, and urogenital and defecatory dysfunction.
Results
In our study, 55 individuals were included (28 received LCA nonpreservation surgery and 27 got LCA preservation surgery). Anastomotic leakage was much lower (3.7%) in the LCA preservation group compared with the nonpreservation group (10.7%). There were no significant differences between the LCA nonpreservation and LCA preservation groups in terms of sexual dysfunction, urine retention, the number of apical lymph nodes, short-term oncologic outcomes, operation time, blood loss, and perioperative morbidity and death.
Conclusions
LCA preservation revealed less anastomotic leakage than LCA nonpreservation in rectosigmoid cancer surgery. Future large volume carefully crafted randomized controlled studies are required to build solid evidence about this issue.

Keywords:
high ligation, left colic artery preservation, low ligation, rectosigmoid cancer

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Introduction

Less strain on anastomosis and greater lymph node retrieval are advantages of not preserving the left colic artery (LCA), but there is also a danger of decreased blood supply at the anastomosis and more harm to the autonomic nerves near the inferior mesenteric artery (IMA) origin [1].

There has not been a recent census on the preservation of the LCA during the removal of colorectal cancer, either in terms of preservation or nonpreservation (high ligation of the IMA, where IMA is ligated at the aortic origin, and low ligation of IMA, where IMA is ligated below the origin of LCA). Most surgeons consider the IMA ligation 2 cm from the LCA's origin to be equivalent to the nonpreservation of LCA [2]. To avoid scarifying the LCA, according to Miles, the IMA should be ligated half an inch below the first sigmoidal branch origin [3]. According to Singh *et al.* [4], LCA nonpreservation provided the patients with IMA-positive lymph nodes with significant survival advantages. Most surgeons recently embraced the preservation of LCA approach, which involves dissecting the apical lymph nodes, keeping the LCA intact, and tying the IMA distally to the LCA [1]. This LCA preservation provides the advantages of improved blood flow and better autonomic nerve preservation, but it also carries the danger of requiring fewer lymph nodes to be removed for tumor staging [1,5].

Dixon made an unusual low ligation of the superior hemorrhoidal artery distal to the sigmoid artery's origin [6].

To evaluate the benefit of LCA preservation in rectosigmoid malignancy. Our oncologic concerns included anastomotic leakage, urogenital dysfunction, and defecatory dysfunction. We also

looked at the number of apical lymph nodes, overall recurrence, and 1-year disease-free survival.

Patients and methods

A prospective equal-allocation randomized controlled study was done. From September 2019 to September 2022, 55 patients with rectal, sigmoid, and rectosigmoid cancer were admitted to the General Surgery Department at the Faculty of Medicine at Menoufia University Hospital and Al-Azhar University Hospital. In our study, 55 individuals were included (28 received LCA nonpreservation surgery and 27 got LCA preservation surgery). This research was performed at the Department of General Surgery, Menofia University and Al-Azhar University. Ethical Committee approval and written, informed consent were obtained from all participants.

All patients underwent a thorough history review, physical examination, laboratory tests, abdominal and pelvic computed tomography, colonoscopy, biopsy, proper preoperative staging, and MDT decision. Patients were randomized systematically using computer-generated sequenced codes with equal allocation of 1 : 1.

We included patients aged from 18 to 60 years with rectal and sigmoid cancer, and we excluded those who were unfit for surgery, had locally advanced tumor, metastatic rectosigmoid cancer, low rectal cancer, and previous abdominal surgery.

We categorized patients into two groups: group A included 28 patients who had nonpreservation surgery for LCA; 11 patients underwent laparoscopic surgery, and 17 patients underwent open anterior resection.

Group B included 27 patients who had preservation for LCA; 12 patients underwent laparoscopic surgery, and 15 patients underwent open anterior resection.

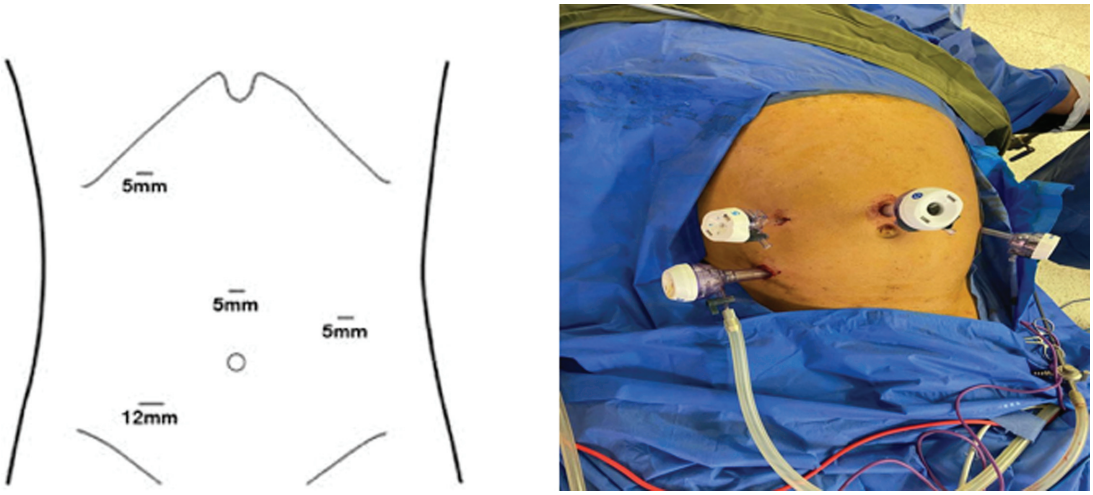
We used the simplified International Index of Erectile Function-5 as a diagnostic tool for erectile dysfunction [7]. Erectile dysfunction scores ranged from 5 to 25, and ED was classified into five categories based on the scores: severe (5–7), moderate (8–11), mild to moderate (12–16), mild (17–21), and no ED (22–25).

Bowel dysfunction was assessed according to answer of questions that addressed stool urgency, frequency, evacuation difficulties, fragmentation of bowel movements, or incontinence [8].

Technique of open traditional surgery

The patient was positioned supine first and then turned into modified Lloyd Davies position during anastomosis and put under endotracheal intubation while receiving general anesthesia. Under anesthesia, the patient's abdomen was inspected. The abdominal midline was inspected. Careful exploration was done to revise respectability after careful preoperative assessment and to exclude metastases. During our dissection, we peeled and dissected all fibro-areolar tissues and lymph node around the root of the IMA with preservation of the LCA in the preservation group. Stapled resection anastomosis of cancer sigmoid was done preserving LCA in 12 patients, whereas nonpreservation was done in eight patients. Hemostasis, peritoneal drainage, and wound closure were done.

Figure 1



Port sites.

Technique of laparoscopic surgery

The patient was positioned supine and put under endotracheal intubation while receiving general anesthesia. The primary surgeon, the cameraman, and the assistant all stood on the patient's right side, with the patient's left side being supported by the assistant. Utilizing a four-port method (Figs. 1–3) laparoscopic exploration was performed to revise the resectability and to rule out metastases. Again, during our dissection, we peeled and dissected all fibro-areolar tissues and lymph nodes around the root of the IMA with preservation of the LCA in the preservation group. Stapled resection anastomosis of cancer sigmoid was done preserving LCA in 11 patients, whereas nonpreservation was done in nine patients. Hemostasis, drainage, and port sites closure were done.

In both laparoscopic and open conventional surgery, the patients were permitted to drink after 48 h, a soft diet on the third day, and a regular diet after 1 week.

Ten days following surgery, the patients were discharged from the hospital. Regular follow-up was carried out at the following intervals: 1 day after surgery, 1 week after, 1 month after, 3 months after, 6 months after, and 1 year after surgery.

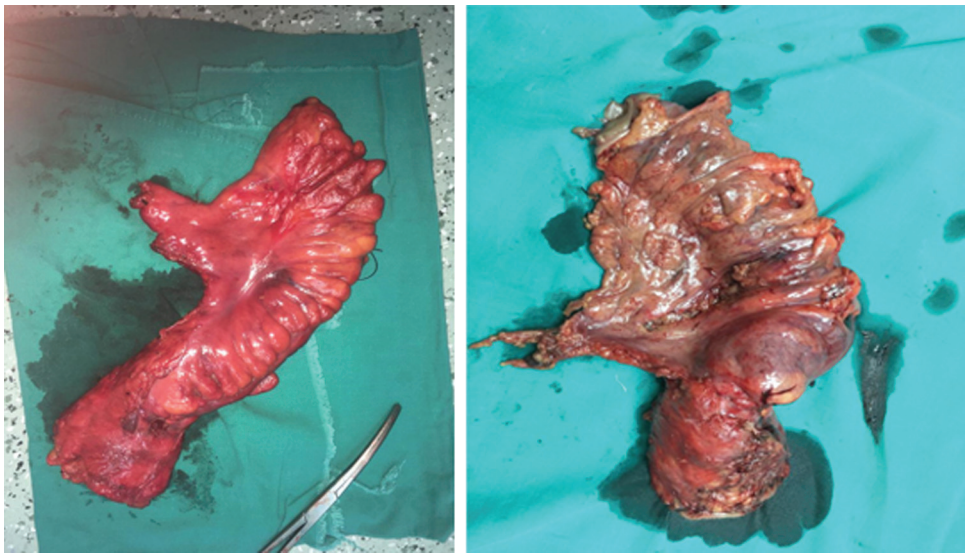
Anastomotic leakage, sexual dysfunction, urine retention, defecatory dysfunction, the number of apical lymph nodes, and short-term oncologic outcomes were evaluated in the patients who were followed up.

Like Komen *et al.* [9], we used a handheld Doppler ultrasound to assess blood flow on the proximal colon's mesenteric side before the anastomosis was built. Blood flow ratios between the LCA preservation and nonpreservation groups were compared. The findings revealed that, independently of blood pressure, blood flow ratio decreased significantly during LCA nonpreservation surgery. There were also other methods of assessment but not used in our study like spectrophotometric assessment of the bowel perfusion using a device called 'Oxygen to See', and cold-steel-test, which involves severing the colic

Figure 2

Specimen after apical dissection of lymph nodes with total meso-colic excision with LCA nonpreservation (note the long pedicle). LCA, left colic artery.

Figure 3



LCA preservation of two different specimens (note the short pedicle). LCA, left colic artery.

marginal artery of Drummond at the tip of the colon stump as measured by Darwich *et al.* [10].

Colorectal anastomosis was established either by circular stapler or by extracorporeal anastomosis through increasing the size of the assistant port to 4 cm in laparoscopic approach. Anvil of circular stapler was introduced to the proximal segment of colon through extended incision made, and the stapler was introduced through anal canal after placing the patient in modified Lloyd Davies position (Fig. 9). In open surgery, colorectal anastomosis was performed by either hand-sewn technique or circular stapler.

Statistical analysis

The sample size was calculated according to the study by Fujii *et al.* [11], which had an anastomosis leakage rate of 5.1% for nonpreservation of LCA versus 2.6% for preservation group in rectosigmoid cancer. We recruited 28 patients for nonpreservation and 44 patients for preservation group, with an attrition rate of 10%. The total sample size needed was 55 patients at confidence interval of 95%, alpha value of 0.05, and power of study of more than 80%.

All data were statistically analyzed using Statistical Package for the Social Sciences (IBM SPSS statistics for windows, Version 23.0. Armonk, NY: IBM Corp). Quantitative data were expressed as a mean±SD, whereas qualitative data were expressed as frequency and percentages. Qualitative variables were compared using χ^2 test, whereas quantitative continuous data were compared using the Mann–Whitney test.

A *P* value less than 0.05 was considered statistically significant. A univariate analysis with nonlinear correlation (cubic spline functions) was used to evaluate the shape of the relationship between the continuous variables and outcome.

We use χ^2 test for categorical variable, whereas one-way analysis of variance test for quantitative variables. Multivariate analysis was used to assess risk factors for anastomosis leakage.

Results

In the current study, 55 patients were included; 27 individuals had LCA preservation, whereas 28 patients underwent LCA nonpreservation.

The mean age of included patients was 40.2±8.9 years, majority of cases were males (63.6%), with no signification difference between two groups regarding age and sex (*P*=0.32) (Table 1, Fig. 4).

Most cases were stages I and II (80%) rectosigmoid cancer, whereas 11 patients were diagnosed with stage III rectosigmoid cancer. The site of tumor was sigmoid in 50% of patients, whereas 32.7% of patients were in upper rectum (Figs 2,3,4). Nearly 49% of patients had received neoadjuvant chemotherapy (Table 1). According to NCCN guidelines, patients with stage III rectosigmoid cancer and patients with middle rectal cancer should receive neoadjuvant chemotherapy [12].

A total of 23 patients underwent laparoscopic anterior resection, and two cases were converted from laparoscopic to open surgery due to adhesions in the abdominal cavity (Table 2, Figs 4 and 5).

Operative time was longer in the preservation group (147.8±28.9 min) than in the nonpreservation group (141.7±31.7), with insignificant difference (*P*=0.46). Blood loss was much more in the preservation group

Table 1 Sociodemographic data and oncology data

Characteristics	Nonpreservation group (*N*=28)	Preservation group (*N*=27)	ANOVA/χ^2	*P* value
Age	40.7±12.3	38.5±11.9	0.987	0.32
Sex [*n* (%)]			0.21	0.43
Male	17 (60.7)	18 (66.6)		
Female	11 (39.3)	9 (33.4)		
Tumor stage [*n* (%)]			0.073	0.964
Stage I	11 (39.2)	11 (39.2)		
Stage II	11 (39.2)	11 (39.2)		
Stage III	6 (21.4)	5 (18.5)		
Site [*n* (%)]			0.09	0.955
Sigmoid	14 (50)	14 (51.8)		
Upper rectum	9 (32.14)	9 (33.3)		
Middle rectum	5 (17.8)	4 (14.8)		
Neoadjuvant chemotherapy	14 (50)	13 (48)	0.019	0.553

ANOVA, analysis of variance.

(241.1±52 min) than in the nonpreservation group (235 ±44.9), with insignificant difference (*P*=0.67) (Table 3).

Regarding oncological outcomes, the number of harvested lymph nodes was slightly more in the nonpreservation group (21.5±3.1) than in the preservation group (20.8±3.3), with insignificant difference (*P*=0.61) (Table 3, Figs 4–9).

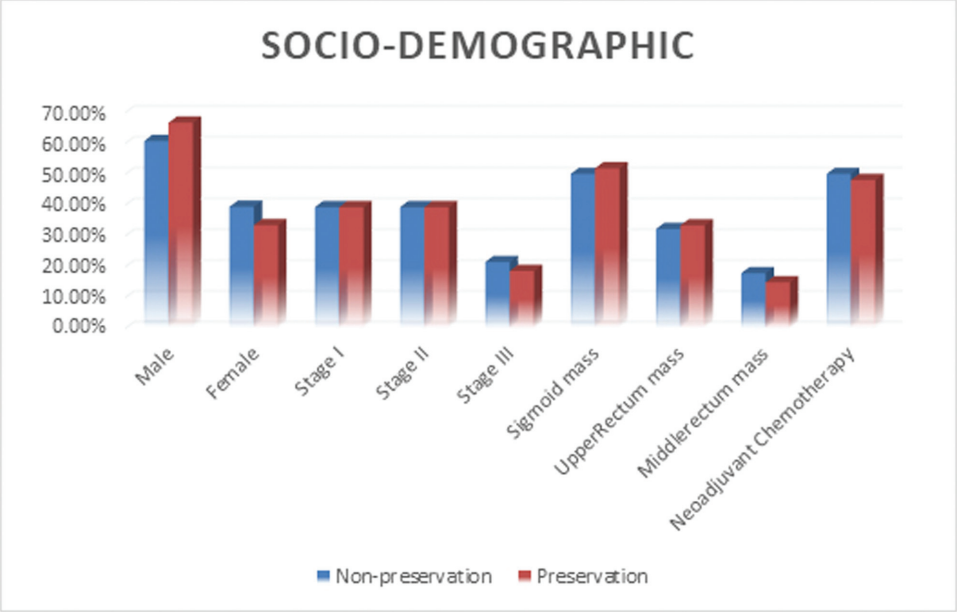
We assessed perfusion of the proximal limb of colon using handheld Doppler. We found inadequate blood

Table 2 Operative data

Characteristics	Nonpreservation group (*N*=28) [*n* (%)]	Preservation group (*N*=27) [*n* (%)]	ANOVA/χ^2	*P* value
Type of surgery			0.15	0.454
Open	17 (60)	15 (55)		
Laparoscopic	11 (40)	12 (45)		
Conversion	1 (9)	1 (8)	0.15	0.926
Perfusion			35.6	0.042
Adequate	13 (76.4)	14 (93.3)		
Inadequate	4 (23.5)	1 (6.7)		
Operative time	141.7±31.7	147.8±28.9	0.544	0.460
Blood loss	235±44.9	241.1±52	0.213	0.647

ANOVA, analysis of variance.

Figure 4



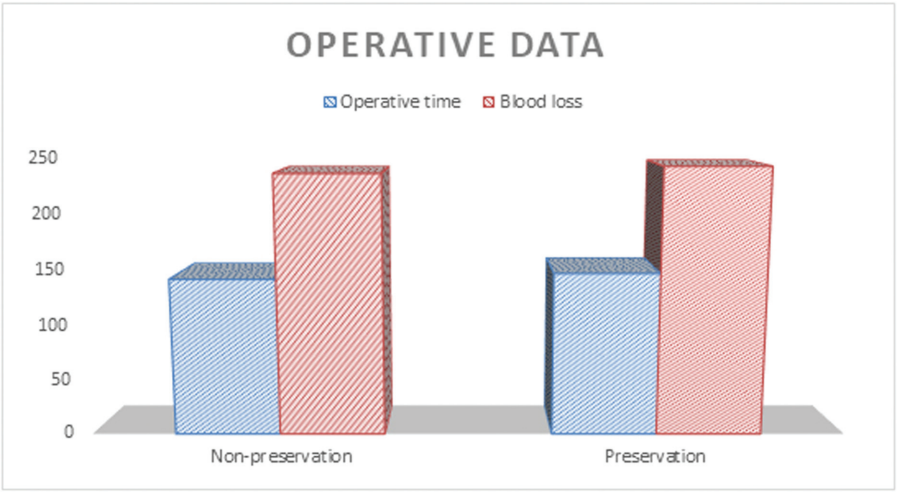
Sociodemographic data.

Table 3 Postoperative outcomes

Characteristics	Nonpreservation group (*N*=28) [*n* (%)]	Preservation group (*N*=27) [*n* (%)]	ANOVA/χ^2	*P* value
Number of LN	21.5±3.1	20.8±3.3	0.617	0.438
Anastomotic leakage	3 (10.8)	1 (3.8)	2.4	0.22
Ileus	3 (10.8)	2 (7.5)	0.669	0.352
Urogenital and defecatory problem	3 (10.8)	2 (7.5)	0.669	0.352
Clavien-Dindo				
Grade I	2 (66)	1 (50)		
Grade II	1 (34)	1 (50)		
Overall survival	2 (7.1)	1 (3.7)	0.12	0.94
Overall recurrence	0	0	0.09	0.99

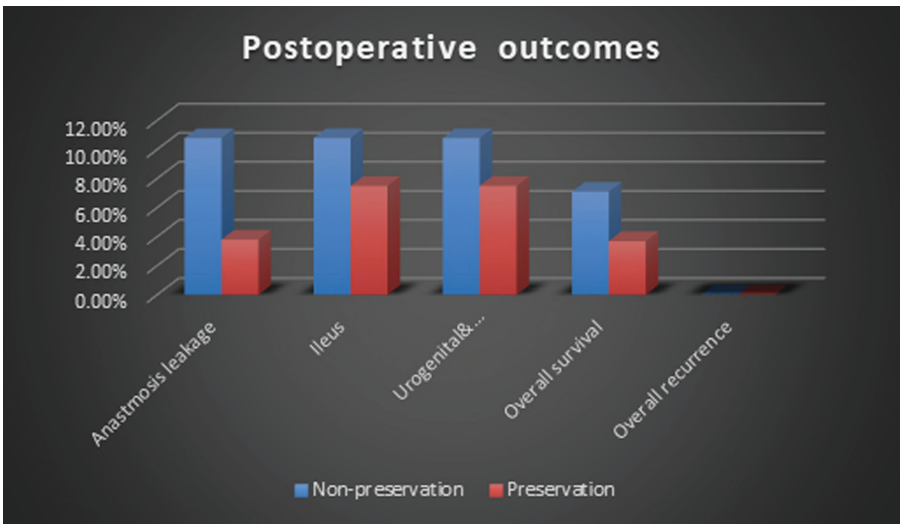
ANOVA, analysis of variance; LN, lymph node.

Figure 5



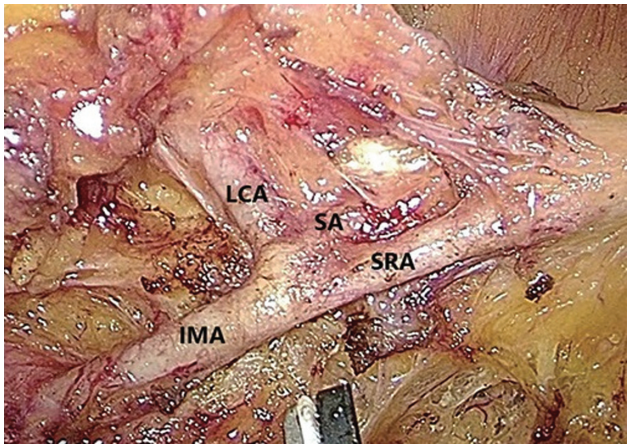
Operative data.

Figure 6



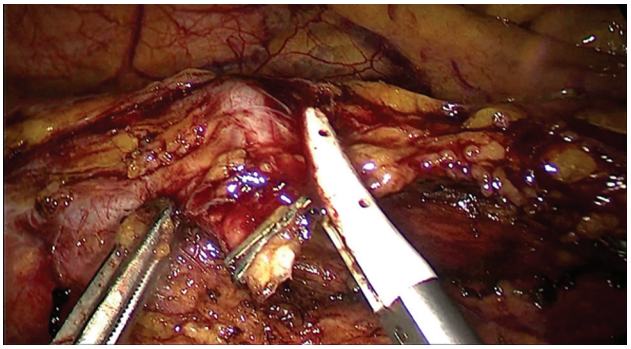
Postoperative outcomes.

Figure 7



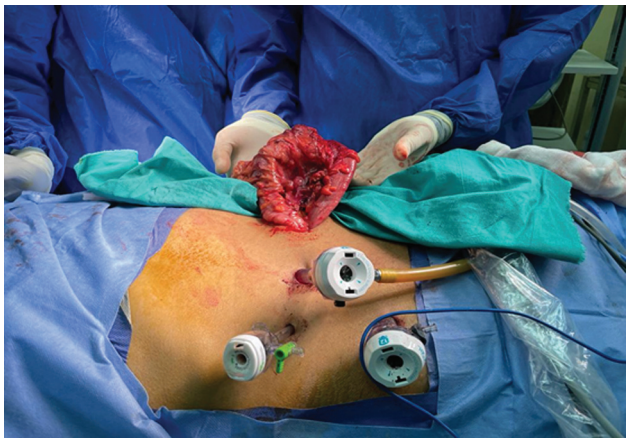
IMA with branches LCA and superior rectal artery SRA. IMA, inferior mesenteric artery; LCA, left colic artery.

Figure 8



Preservation of LCA. LCA, left colic artery.

Figure 9



Site of ports insertion with extracorporeal anastomosis.

flow in the preservation group in one case of 15 cases (in open surgery), whereas four of 17 cases was found with inadequate blood flow (in open surgery), with significant difference (P=0.03).

Three (10.7%) cases developed anastomosis leakage in the nonpreservation group, whereas one case developed anastomosis leakage in the preservation group (3.7%), with insignificant difference (P=0.22) (two cases that underwent hand sewn and one case with stapler in the nonpreservation group and one case with stapler in the preservation group) (Table 3).

Five patients developed ileus, and five patients developed urogenital and defecatory dysfunction, with insignificant difference between two groups (P=0.51) (Table 3).

The overall survival rate in 1 year was 94.5%, and the overall recurrence rate at 1 year was 3.6%, with no discernible difference between the two groups.

Multivariate analysis was done for assessment of factors affecting anastomosis leakage, which revealed age, perfusion of proximal limb, and nonpreservation of LCA as the predominant factors (RR: 1.05, 1.3, and 1.42, respectively, with significant P=0.05, 0.023, and 0.012, respectively). Use of stapler or hand-sewn for anastomosis had no affection on leakage as two cases of patients with hand-sewn anastomosis develop leakage versus one case in stapler technique, with insignificant difference (P=0.86). Moreover, neoadjuvant chemotherapy had no effect on development of leakage, as two cases among patients who received neoadjuvant chemotherapy develop leakage versus one case in patients who did not receive, with insignificant difference (P=0.71).

Discussion

The preservation of LCA during sigmoid and rectosigmoid cancer procedures is still up for dispute. Regarding the preservation of LCA after left colon and rectal cancer surgery, there is currently no universally accepted agreement. To evaluate the short-term outcomes of LCA preservation against LCA nonpreservation following colorectal resection in our departments, we conducted this randomized experiment. Our findings update the most recent randomized experiment on this fascinating subject, which was constrained by an insufficient sample size.

In terms of operation time, our study demonstrates that the preservation group required more time (147.8 ±28.9 min) than the nonpreservation group (141.7 ±31.7), even though this difference was not statistically significant (P=0.46). The studies by Koman and colleagues and Lee and colleagues also demonstrated that the preservation group required more time during surgery than the nonpreservation group [9,13]. However, in terms of bleeding, significantly higher blood loss occurred in the preservation group (241.1 min) compared with the nonpreservation group (235 min) (P=0.67). We agreed with the studies by Matsuda *et al.* [14] and Shen *et al.* [15] that there was no appreciable blood loss between the two groups.

Nonpreservation of LCA during laparoscopy is more straightforward owing to the spread of laparoscopy in rectosigmoid surgery [16]. This is because preserving LCA while dissecting apical lymph nodes requires complicated technical work and takes a lot of time.

Five individuals in the current study experienced ileus, with no discernible difference between the two groups. The lower blood flow in the LCA nonpreservation group may affect bowel movement [17].

Intriguingly, we reported a statistically significant difference in anastomotic leakage between the LCA preservation and nonpreservation groups because three patients (10.7%) in the nonpreservation group had anastomotic leaking. However, there was one instance of anastomosis leakage in the preservation group (3.7%), with insignificant difference (P=0.22).

Anastomotic leaking can occur anywhere between 2.2 and 12% of the time [9]. The most important risk factor influencing anastomotic leakage is anastomosis blood perfusion [13]. The IMA is cut at its aortic origin as part of the LCA nonpreservation surgical procedure

to provide a low pelvic anastomosis without strain. However, the distal colon is entirely dependent on the marginal artery that emerges from the middle colic artery following high IMA ligation, even though several tests had shown that the marginal artery had adequately supplied the colon's remaining tissue with blood [16,18].

We used a handheld Doppler to examine the perfusion of the proximal limb of the colon. We discovered insufficient blood flow in the preservation group in one of 15 cases (open surgery), and in four of 17 cases (open surgery), with a significant difference (P=0.03). Komen and colleagues and Guo and colleagues asserted that nonpreservation of LCA severely decreased blood circulation of the proximal leg based on prospective intraoperative evaluation [19].

Additionally, Dworkin and Allen-Mersh discovered that there was no increase in perianastomotic colonic perfusion during the first five postoperative days, and a 41–86% blood flow drop after LCA was not preserved. In addition, failure to preserve LCA in older individuals with atherosclerotic alterations in arteries may lead to hypoperfusion of the proximal limb [17]. On the contrary, the splenic flexure is mobilized and the LCA is preserved, which results in sufficient blood supply to the proximal anastomosis and a reduction in anastomotic leak [19]. Our findings led us to conclude that maintaining LCA provided the significant benefit of ensuring sufficient perfusion of the proximal anastomosis and lowering postoperative anastomotic leakage.

Urogenital and anorectal dysfunction, a frequent consequence following anterior resection, had a considerable effect on patients' postoperative quality of life. To avoid urogenital and anorectal dysfunction, the maintenance of pelvic autonomic nerves is essential [20]. According to several research, for superior hypogastric plexus lesions brought on by high IMA ligation, LCA preservation was linked with less postoperative urogenital dysfunction compared with LCA nonpreservation [21]. Our research, however, demonstrated that there was no significant difference between the LCA preservation group and the LCA nonpreservation group in terms of sexual dysfunction and urine retention.

Preaortic and inferior mesenteric nerves might be recognized and protected during high IMA ligation thanks to the development of precise laparoscopy-assisted surgery. On the contrary, high IMA ligation generates a lengthy denervated colon segment that results in defecatory function by interfering with the descending autonomic fibers [17,22]. According to Matsuda and colleagues and Wang and colleagues this problem could become better with time following the procedure [16].

In colorectal illness, the quantity and health of lymph nodes are crucial prognostic indicators. In pT3/T4 sigmoid colon cancer and rectal cancer, the rate of lymph nodes metastasizing around the root of the IMA was observed to be 3.6 and 5.1%, respectively [15]. According to our research, there was no discernible difference between the two groups in the quantity of apical lymph nodes extracted around the root of the IMA. To confirm radicality, during our dissection, we dissected all fibro-areolar tissues and lymph nodes around the root of the IMA with preservation of the LCA in the preservation group. The findings ran counter to earlier research that suggested LCA nonpreservation surgery would enhance lymph node collection and, as a result, increase the precision of tumor staging [2]. This could be because those investigations preserved LCA without dissecting the apical lymph nodes. This investigation demonstrated that in patients with rectosigmoid cancer curative resection, LCA nonpreservation was not linked with a substantially superior short-term oncologic outcomes compared with LCA preservation [5,13,23]. Although Singh's most recent meta-analysis of the group of patients with IMA-positive lymph nodes demonstrated a substantial overall survival advantage of LCA nonpreservation versus LCA preservation, there was no meaningful difference in the total case group [6]. The findings of Chen and colleagues that nonpreservation of LCA had superior 5-year overall survival may be constrained by the inclusion of studies that were written before 2000 [14]. In the current study, we were adherent to perfect anastomosis, and surgeries were performed with the same surgical team. Most reported studies concluded that stapled and hand-sewn sutures had similar outcomes in terms of complications [24]. That is why, we used stapler and hand-sewn techniques without worrying about settling differences.

Conclusion

In terms of anastomotic leakage, the current study revealed that LCA preservation is preferable than LCA nonpreservation for decreasing the incidence of leak. There was no significant difference between the LCA nonpreservation and LCA preservation in terms of sexual dysfunction, urine retention, the

number of apical lymph nodes, or short-term oncologic outcomes.

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Conflicts of interest
There are no conflicts of interest.

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