

Original Research Article

Apical lymph node dissection of the inferior mesenteric artery with preservation of left colic artery in colorectal cancer

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ABSTRACT

Background: Nowadays, surgery for colorectal cancer has been standardized both ways in open and laparoscopic approaches but there are still debates regarding the level of ligation of the IMA at its origin from aorta (high ligation) or below the origin of left colic artery (low ligation). The technique of apical lymph node dissection with preservation of LCA has the advantage of both, better lymph node harvest and lower postoperative complications. It is controversial whether a high or low ligation of the inferior mesenteric artery (IMA) is superior. The former allows an extended lymph node clearance whereas the latter preserves the distal vascular supply via the left colic artery (LCA). Apical lymph node dissection of the IMA (ALMA) harvests nodal tissue along the IMA proximal to the LCA whilst performing a low ligation. This anatomically replicates the oncological benefit of high ligation and the vascular preservation of low ligation. This study evaluates the nodal yield of ALMA and the short-term outcome of this technique.

Methods: Author retrospectively studied 40 patients with operable sigmoid and rectal cancer who admitted to general surgery department in Menoufia University Hospitals from May 2016 to May 2018. All patient underwent curative surgical resection with ALMA. The lymph node yield from the dissection (the ALMA specimen) was compared with the total lymph node yield. Data on the LCA anatomy, time required to perform ALMA, complications and postoperative recovery were evaluated.

Results: Results ALMA was successful in 36 patients. Median postoperative hospitalization was 5 (2-26) days without ALMA-related morbidity or mortality. The median lymph node yield was 20 (9-41) and a median of 14.3 (0-80)% were harvested with ALMA. Two patients not having neoadjuvant chemoradiotherapy had fewer than 12 lymph nodes, excluding nodes harvested from ALMA. The average time required for ALMA was 20min.

Conclusions: ALMA (lymph node dissection around the IMA preserving the root of the IMA and LCA) was feasible by this method without compromising operation time, blood loss or the number of harvested lymph nodes with accepted rate of postoperative complications.

Keywords: Apical lymph node, Inferior mesenteric artery, Left colic artery

INTRODUCTION

Incidence of colorectal cancer and mortality rates vary around the world. Globally, colorectal cancer is the third most commonly diagnosed cancer in men and the second

in women.¹ Surgical treatment of colorectal cancer has changed radically in recent years. The introduction of total mesocolic excision, neoadjuvant therapy protocols, and the laparoscopic approach has made colorectal cancer treatment a multidisciplinary management.² Lymph node

dissection carries prognostic and therapeutic implications. Lymphadenectomy for colorectal adenocarcinomas should extend to the level of the origin of the primary nurturing vessel. During surgery for left colonic and rectal cancers, the inferior mesenteric artery (IMA) can be ligated either at its aortic origin (high tie) or below the origin of the left colic artery (low tie). There is no consensus as to which method should be employed.³

Previous guidelines did not advocate routine ligation of the Inferior Mesenteric Artery (IMA) beyond Left Colic Artery (LCA) take off unless there was evidence of tumor metastasis in this region. However, a retrospective analysis of more than 2400 patients, comparing the outcomes of high and low ligation on survival showed that high ligation reduced distant metastasis and local recurrence and improved survival in certain stages of colorectal cancer.⁴

The level of arterial ligation can affect genitourinary function (injury to the superior hypogastric plexus), the extent (and yield) of lymphadenectomy and distal colonic arterial perfusion (especially in older people, in whom distal colonic arterial perfusion could be deficient due to arterial degenerative disease).⁵

Apical lymph node dissection of the inferior mesenteric artery (ALMA) harvests the nodal tissue proximal to the branch of the left colic artery whilst performing a low ligation and anatomically replicates the oncological benefit of high ligation and the vascular preservation of low ligation. This technique is suitable for both high and low anterior resection, although preservation of the LCA may compromise the adequacy of colonic length for low colorectal or coloanal anastomosis.⁶

METHODS

This study included 40 patients diagnosed as having adenocarcinoma of the rectum or the sigmoid colon between May 2016 and May 2018 at the Surgical Department, Menoufia University Hospitals. The duration of follow-up was a median of 6 months. The demographics and perioperative data for the patients are shown in Table 1.

Table 1: Mean value±standard deviation of age in years of studied group.

Variable	Mean±SD	Range
Age in years	54.6±4.3	49-63

The study was reviewed and approved by the ethics committee of Menoufia university hospital. In most cases the distance from the aorta of the branching of the LCA from the IMA was measured with a silk tie. Apical lymph nodes dissected around the IMA were examined as a separate histopathological specimen. The time required was defined as the interval from initial dissection of the root of the IMA to the moment before ligation of the

Superior Rectal Artery (SRA). Data were analysed with SPSS version 21. The Mann-Whitney U-test was used to evaluate correlation between extent of lymph node dissection and apical lymph node yield. Informed written consent was obtained from individual Patients.

Only operable cases of sigmoid or rectal cancer fulfilling MRI or Computed Tomographic (CT) scan criteria, which include no permeation of surrounding fat planes, no encasement of major vascular structures, no extensive local spread and no distant metastases or peritoneal infiltration were included in this study.

All cases with perforation or obstruction, metastatic cases, patients with low rectal tumors that necessitate abdominoperineal resection, and patients with synchronous lesions in a part of the colon other than the left colon or rectum were excluded from the study.

All the patients were subjected to colonoscopic biopsy of the tumor, thorough clinical examination, imaging studies such as MRI or CT of the abdomen and pelvis and metastatic workup (ultrasound of the abdomen and chest radiography).

A total of 25 of the patients underwent neoadjuvant therapy. All patients were eligible for general anesthesia (American Society of Anesthesiologists 1-4).

Preoperative assessment of genitourinary functions was carried out for all patients as follows

- Uroflowmetric study and ultrasound measurement of postvoid bladder volume,
- Questionnaires for the International Index of Erectile Function,⁷
- International consultation on incontinence questionnaire,⁸
- The female sexual function index to assess the genitourinary functions both preoperatively and postoperatively.⁹

All patient underwent curative surgical resection with ALMA. The lymph node yield from the dissection (the ALMA specimen) was compared with the total lymph node yield. Data on the LCA anatomy, time required to perform ALMA, complications and postoperative recovery were evaluated. The surgical technique were standard (open or laparoscopic) resection of the sigmoid or the rectum was performed for all patients.

ALMA was performed in patients undergoing curative left-sided resection for tumours distal to the mid sigmoid colon. Author defined the LCA as the first branch of the IMA traversing towards the descending colon, the IMA pedicle was mobilized medially. A plane was found between the vascular sheath and the tunica adventitia. The IMA with the proximal LCA was skeletonized. A length of silk was used to measure the distance of the LCA from the aorta. The IMA was divided just distal to

the LCA and the dissection retrieves tissue up to the inferior mesenteric vein (IMV), which was divided at the same level as the IMA (Figure: 1 and 2). Tissue retrieved is sent and evaluated separately from the main specimen. Routine surgery was performed after ALMA.

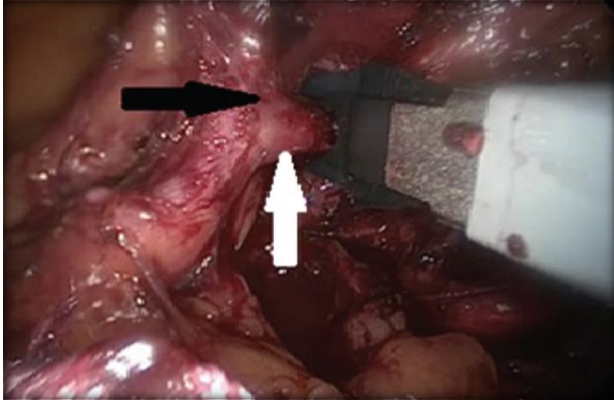


Figure 1: Clipping of the superior rectal artery (black arrow=left colic artery, white arrow=inferior mesenteric artery).

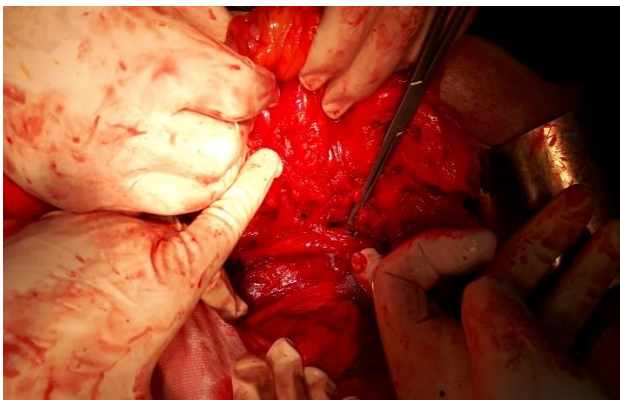


Figure 2: Ligation of superior rectal artery.

The IMA was ligated below the takeoff of the LCA above the level of sacral promontory, the lymph node around the origin of the artery was dissected by peeling the areolar and lymphatic tissue off the vascular sheath of the artery at its origin. The dissection was continued in caudal direction until the LCA was encountered and preserved (Figure: 3 and 4).

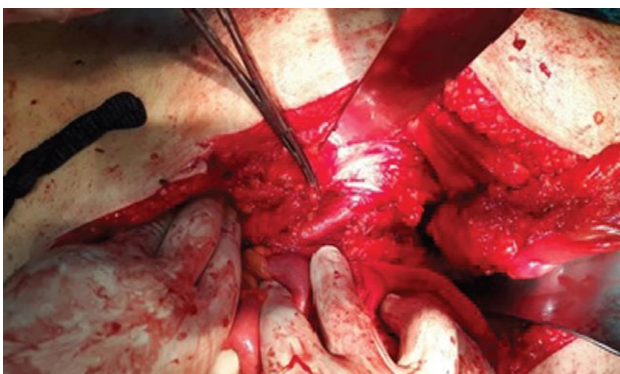


Figure 3: Apical lymph node dissection.

Postoperative evaluation: In the immediate postoperative period, the patients were monitored closely for manifestations of fecal fistula. In doubtful cases, CT of the abdomen and pelvis was performed to detect minor leakage (pericolic abscess or collection).

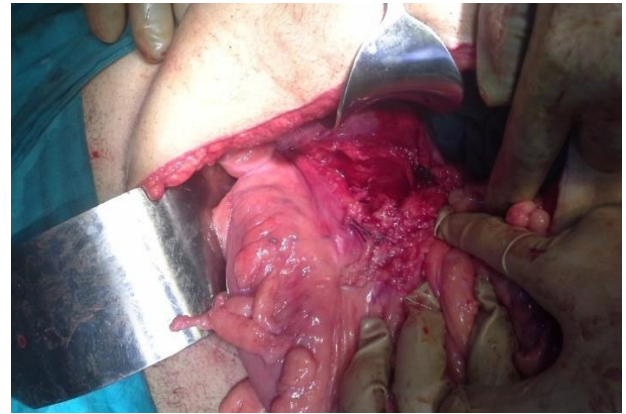


Figure 4: Apical lymphnode dissection.

Lymph nodes were collected for histopathological examination. The number of retrieved and positive lymph nodes on the root of the IMA, the total number of lymph nodes on the specimen and the number of positive lymph nodes on the specimen were recorded.

Questionnaires for the International index of erectile function, International consultation on incontinence questionnaire and the Female Sexual Function Index were administrated to every patient at 3 and 6months postoperatively.

Uroflowmetry and ultrasound measurement of postvoid bladder volume was performed 3 and 6months postoperatively.

RESULTS

This study included 40 patients who had operable colorectal cancer, they were treated by anterior resection and low anterior resection and apical lymph node dissection at root of inferior mesenteric artery with preservation of left colic artery. The collected results were statistically analyzed taking the consideration which were age distribution, preoperative chemotherapy, side, site and size of the colorectal lesion, pathologically affected lymph nodes number, number of cases with successful apical lymph node dissection and number of positive nodes, blood loss and operative time and postoperative complication.

The data collected were tabulated and analyzed by SPSS (Statistical Package for the Social Science Software) statistical package version 20 on IBM compatible computer. Quantitative data were expressed as mean and

standard deviation ($X \pm SD$). Qualitative data were expressed as number and percentage (No and %). A total of 40 patients (29 (72.5%) male, 11 (27.5%) female, mean age 54.6 ± 4.3 years) were selected for this prospective study from all patients operated for distal colorectal cancer in this department (Table 1 and 2) (Figure 5).

Table 2: Number and percentage of gender.

Gender	No	%
Male	29	72.5
Female	11	27.5

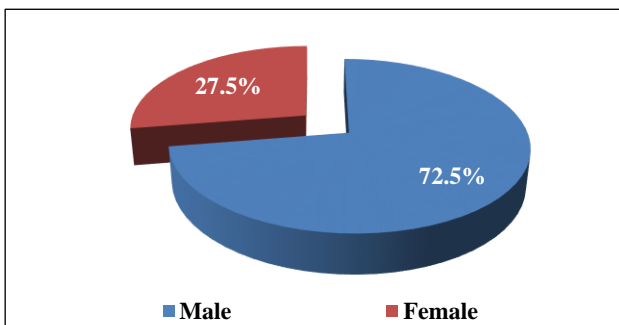


Figure 5: Percentage of sex of studied group.

Regarding the age and gender of the patients in this study: (29 (72.5%) male, 11 (27.5%) female with age ranged from 49-63 years with mean value of 54.6 ± 4.3). Regarding site, tumors were located in the sigmoid (n=17, 42.5%), rectosigmoid and upper rectum (n=9, 22.5%) and mid rectum (n=11, 27.5%) (Figure 6).

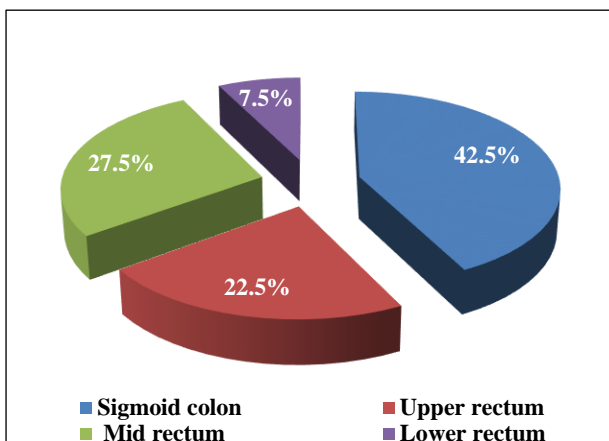


Figure 6: Percentage of tumor site.

Of the 23 patients with rectal tumors, 18 underwent neoadjuvant chemoradiation (n=18, 78.3%). Of the 23 patients of rectal tumors, 18 received neoadjuvant therapy (n=18, 78.0%).

One patient who did not have neoadjuvant chemoradiotherapy had fewer than 12 lymph nodes

excluding the ALMA specimen indicating that a low ligation for this patient would have been oncologically inadequate.

Patients underwent sigmoid resection (n=17, 42.5%), anterior resection (n=9, 22.5%) or low anterior resection (n=11, 27.5%) and Ultralow anterior resection (n=3, 7.5%). Difficulties found in 3 cases of ultralow anterior resection regarding technique as it affected length of proximal end and subsequently high ligation was done to secure a tension-free anastomosis. Anastomotic leakage was detected in (n=3, 7.5%) and genitourinary complication in (n=1, 2.5%). This was compatible with autonomic nerve preservation and preservation of sexual function with no observed loss in urinary function. None of cases needed re operation or prophylactic ileostomy (Figure 9).

Mean \pm SD of blood loss during operation (109.5 ± 84.7). Which was reasonable indicating no blood loss with this technique. The mean number of harvested lymph nodes was 18.17 ± 5.5 . Detected apical lymph nodes mean number (3.1 ± 2.1) with range (0.0-7.0) (Figure 7).

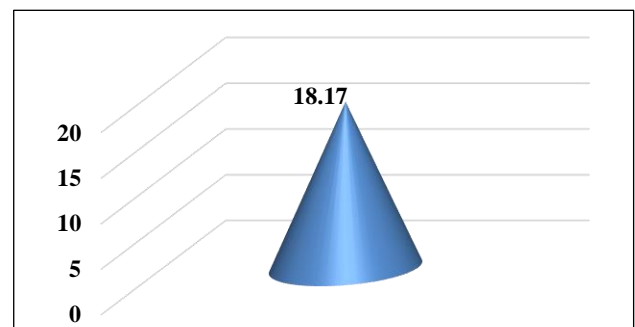


Figure 7: Mean \pm SD of total lymph node harvest.

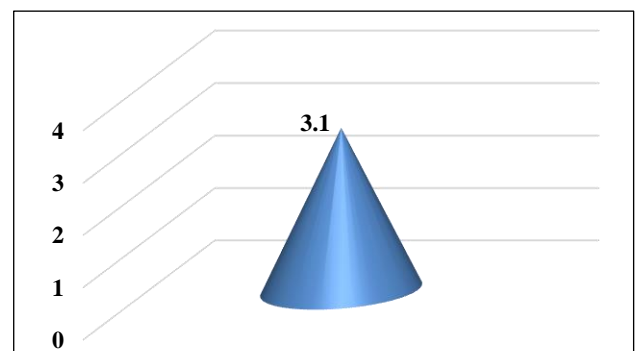


Figure 8: Mean of harvested apical lymph nodes.

Two patients not having neoadjuvant chemoradiotherapy had fewer than 12 lymph nodes, excluding nodes harvested from ALMA. Apical lymph node dissection was successful in 38 cases with detection of positive apical lymph nodes in 8 cases (21.0%) (Figure 8). This was highly significant that this technique preserves oncological benefit with lymph node harvest. Regarding site of tumor Tumors were located in the sigmoid (n=17,

42.5%), rectosigmoid and upper rectum (n=9, 22.5%) and mid rectum (n=11, 27.5%). Of the 23 patients with rectal tumors, 18 underwent neoadjuvant chemoradiation (n=18; 78.3%). The mean number of harvested lymph nodes was 18.17 ± 5.5 . Detected Apical lymph nodes mean number (3.1 ± 2.1) with range (0.0-7.0). Detected Apical lymph nodes mean number (3.1 ± 2.1) with range (0.0-7.0).

Anastomotic leakage was detected in (n=3, 7.5%) and genitourinary complication in (n=1, 2.5%). This was compatible with autonomic nerve preservation and preservation of sexual function, with no observed loss in urinary function. None of cases needed re operation or prophylactic ileostomy. Regarding site, tumors were located in the sigmoid (n=17, 42.5%), rectosigmoid and upper rectum (n=9, 22.5%) and mid rectum (n=11, 27.5%) (Table 3) (Figure 6).

Table 3: Number and percentage of tumor site.

Tumor site	No	%
Sigmoid colon	17	42.5
Upper rectum	9	22.5
Mid rectum	11	27.5
Lower rectum	3	7.5

Of the 23 patients with rectal tumors, 18 received neoadjuvant chemoradiation (n=18, 78.3%) two patients not having neoadjuvant chemoradiotherapy had fewer than 12 lymph nodes, excluding nodes harvested from ALMA (Table 4).

Table 4: Number and percentage of rectal tumor cases received neoadjuvant therapy.

Neoadjuvant	Number	%
Received	18 of 23cases	78.0

Table 5: Type of operation.

Surgery	Number	%
Sigmoid resection	17	42.5
Anterior resection	9	22.5
Low anterior resection	11	27.5
Ultralow anterior resection	3	7.5

Patients underwent sigmoid resection (n=17, 42.5%), anterior resection (n=9, 22.5%) or low anterior resection (n=11, 27.5%) and Ultralow anterior resection (n=3, 7.5%) (Table 5). Anastomotic leakage was detected in (n=3, 7.5%) and genitourinary complication in (n=1, 2.5%) (Table 6) (Figure 9). Mean \pm SD of blood loss during operation (109.5 ± 84.7) (Table 7). The average time required for ALMA was 18min. The mean number of harvested lymph nodes was 18.17 ± 5.5 . Detected apical lymph nodes mean number (3.1 ± 2.1) with range (0.0-7.0) (Table 8). Cases with positive lymph nodes (n= 19, 47.5) (Figure 7 and 8). Apical lymph node dissection was

successful in 38 cases with detection of positive apical lymph nodes in 8 cases (21.0%). Skip metastasis was found in one specimen (2.6%) (Table 9). No patient in this study needed covering ileostomy. The hospitalization period was 10.6, 4 ± 0.7 days without ALMA related morbidity or mortality.

Table 6: Percentage of cases with postoperative complication.

Postoperative complication	Number	%
Anastomotic leakage	3	7.5
Genitourinary complication	1	2.5

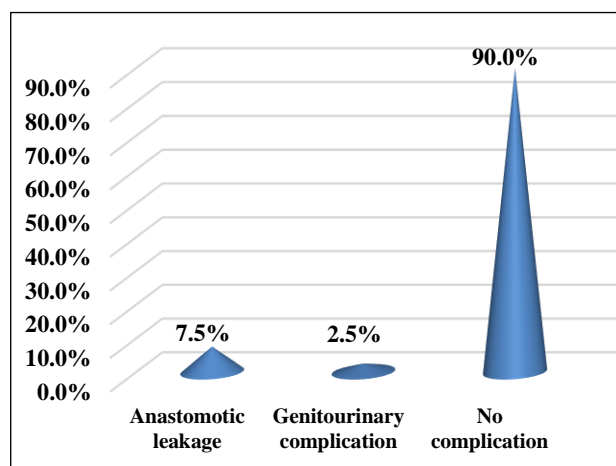


Figure 9: Percentage of post-operative complication.

Table 7: Mean \pm SD of blood loss during operation.

Variable	Mean \pm SD	Range
Blood loss/mL	109.5 ± 84.7	50.0-500.0

Table 8: Mean \pm SD total number of harvested LNs and positive cases.

Variable	Mean \pm SD	Range
TLN	18.17 ± 5.5	10.0-28.0
Detected apical lymph node	3.1 ± 2.1	0.0-7.0

Table 9: Cases of detected apical lymph nodes and percentage of its positivity.

Variable	No.	%
Cases with positive nodes	19	47.5
Cases with dissected apical lymph nodes	38	95
Cases with positive nodes	8	21.0

DISCUSSION

The level of lymph node invasion and the number of nodes involved have been shown to be significant prognostic factors in patients with colorectal cancer. However, there was no consensus on the level of arterial ligation in distally located disease.⁹ Proponents of high

ligation believe that its oncological benefit was superior to the loss of the vascular supply from the left colic artery.^{3,4} Proponents of low ligation believe the opposite but ALMA combines the best of both techniques. Its main disadvantage was a longer operating time and potentially greater morbidity, and the mobility of the colon was less than that after high ligation, which may be an important consideration when performing a low anastomosis, although the authors did not experience any difficulty with the 11 low anterior resections in which ALMA was used. Difficulties were in ultralow anterior resection. Studies evaluating survival rates, conducted by Lange and colleagues between high (at the origin of IMA) and low-intermediate (after the branching of the LCA) ligation have generally shown no significant difference between the two techniques.¹⁰ In contrast, Pezim and Nichols, in a retrospective analysis evaluating more than 2400 patients who underwent high ligations of IMA versus ligation of the superior rectal artery, showed reduced distant metastasis and local recurrence rates as well as improved survival in the IMA group in certain stages of colorectal cancer.¹¹ Pezim ME et al, and Chin et al, indicated that the high tie contributed to survival prolongation. They reported that the 5-year survival rate of patients who had lymph node metastasis around the IMA but underwent lymph node dissection up to the root of the IMA was as good as 40%.^{12,13}

In a study of Goh N and colleagues, ALMA was successful in 18 patients. Median postoperative hospitalization was 5 (2-26) days without ALMA-related morbidity or mortality. The median lymph node yield was 20 (9-41) and a median of 14.3 (0-80) % were harvested with ALMA. Indicating that ALMA is a safe and feasible technique allowing extended lymphadenectomy without sacrificing the LCA.⁶

In this study, lymph nodes could be visualized in all patients (100%). The mean number of harvested lymph nodes was 18.17 ± 5.5 (range 10.0-28.0). Detected Apical lymph nodes mean number (3.1 ± 2.1) with range (0.0-7.0). Cases with positive lymph nodes (n= 19, 47.5) (Table 8 and 9) (Figure 8). Apical lymph node dissection was successful in 38 cases with detection of positive apical lymph nodes in 8 cases (21.0%). Data collected by Goh N et al, were very similar to this study and their meta-analysis reported a greater lymph node yield (the median lymph node yield was 20 (9-41)).⁶ Data in the literature have revealed that the apical lymph node positivity rate might reach 9.6%, and the pathology evaluation in this study showed that the tumor invasion rate at apical nodes was 13.9%.^{14,15} This is an important finding, which may lead us to perform apical lymph node dissection for all patients with distal colorectal cancer, because, otherwise, more than 10% patients would actually have metastasis at this site. The second reason that may lead us to perform such dissection is skip phenomena. Skip metastasis occurred in apical nodes in 2.6% of this patient. This coincides with the findings of Sieke et al, who found it in 1.9% of his patients.¹⁶

Despite the oncological advantage of high ligation, it has many drawbacks such as reduced blood flow to the descending colonic limb and the possible injury of the superior hypogastric autonomic plexus and nerves. Anastomotic leak, in the form of fecal fistula or pericolic abscess is a major and devastating complication of colorectal procedures. From the technical point of view, the effect of high ligation on anastomotic integrity is controversial. After high ligation of IMA, the vascularization of the proximal limb completely depends on the middle colic and marginal arteries. Some authors therefore believe that high ligation significantly reduces the blood flow and consequently may jeopardize the safety of the anastomosis.¹⁷ Dworkin MJ et al, assessed the influence of clamping of the IMA using doppler flowmetry.¹⁸ They showed that the blood flow to the sigmoid colon fell by 50% within 5days postoperatively. Others, however, maintain that high ligation was often essential to secure a tension-free anastomosis.¹⁹ In this study, among 40 patients who underwent colorectal anastomosis, the incidence of risk for anastomotic leak was 7.5% (n=3) (Table 6) (Figure 9), which was reasonable and comparable to other studies in the literature, such as that by Hida JI et al, who found 6.3% leakage rate among their patients (seven of 112). Two of these patients required re-exploration and Hartman procedure was performed, whereas the other four patients were managed conservatively.¹⁴

For many years, severe urogenital dysfunction has been accepted as normal following colorectal cancer surgery. Reasons for the high rates of denervated bladder and impotence were the anatomy and pathophysiology of autonomic pelvic nerves that were only poorly understood by surgeons and the commonly used blunt dissection technique. Genitourinary dysfunction occurred in 2.5% of the patients, this is similar to data collected by Havenga et al, who reported that the total mesorectal excision and high ligation of the IMA is compatible with autonomic nerve preservation and reported preservation of sexual function in 85% of cases with no observed loss in urinary function.²⁰

CONCLUSION

Lymph node dissection around the IMA preserving the root of the IMA and LCA (ALMA) was feasible with this method without compromising operation time, blood loss, or the number of harvested lymph nodes. It has the advantage of both preservation of blood flow, which could contribute to improvement of the leakage rate and avoidance of inadvertent injury of autonomic nerve plexus around the origin of the IMA. Although long-term oncological benefit is uncertain from this small study with limited follow up, it enables approximately 10% more lymph nodes to be harvested while preserving the vascular supply from the LCA.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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