



A Comparison between Different Management Surgical Approaches in the Treatment of Splenic Flexure Colon Cancer

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Abstract

Background There are many surgical approaches which described extent of resection of the colon for adequate surgical management of splenic flexure cancer, but up till now there is no established surgical procedure, this is because the presence of double lymphatic drainage of the mesenteric vessels. Segmental resection of the colon for the management of splenic flexure cancer was a recently accepted surgical procedure.

Objective In the present study, we aimed to compare three surgical management techniques to clarify the best management approach of Egyptian patients with splenic flexure cancer regarding operative, clinical, and oncological outcomes: segmental resection, and extended left or right hemicolectomy.

Materials and Methods In the present study, we included 90 patients with splenic flexure cancer. Cases were divided into 3 groups. Each group included 30 patients in order to compare three surgical techniques: segmental resection, extended left hemicolectomy, and extended right hemicolectomy.

Results We have found no statistically significant differences between the three included groups regarding operative findings, postoperative complications, local recurrence, distant recurrence, disease progression, recurrence-free survival rate, progression-free survival rate, and overall survival rate. The operative time was longer,

Keywords

- ▶ splenic flexure cancer
- ▶ surgery
- ▶ segmental resection
- ▶ outcome

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and the number of lymph nodes was higher in the extended right hemicolectomy group ($p < 0.001$).

Conclusion We have shown that segmental resection of the splenic flexure is surgically and clinically suitable for the adequate management of operable cases of carcinoma of the splenic flexure.

Introduction

Splenic flexure cancer is a type of colon cancer that is located in the left corner of the colon, in the distal part of the transverse colon, or in the proximal part of the descending colon. It is considered a rare anatomical variant of colon cancer.¹ It is diagnosed late in advanced stage, mostly with obstructive manifestations.² There are many surgical approaches that describe the extent of resection of the colon for successive management of splenic flexure cancer, but there is no established surgical procedure due to double lymphatic drainage of the mesenteric vessels.^{3,4} Many authors tried to identify the best surgical approaches for the management of splenic flexure cancer, either open or laparoscopic, extracorporeal or intracorporeal anastomosis.² Few surgeons accept the performance of segmental resection of the colon for the management of splenic flexure cancer.^{5,6}

There are few published reports that assessed the benefits of segmental resection in comparison with extended colectomy to detect the best approach for the surgical management of splenic flexure cancer. Rega et al.¹ tried in their retrospective study to detect the benefits of segmental resection and have showed similar oncological benefits from extended colectomy and segmental resection. To our knowledge, there are no prospective studies that compared the outcome of Egyptian patients with splenic flexure cancer who were managed by different surgical techniques.

In the present study, we aimed to compare three surgical management techniques to clarify the best management approach of Egyptian patients with splenic flexure cancer regarding operative, clinical and oncological outcomes: segmental resection, and extended left or right hemi-colectomy.

Materials and Methods

In the present study, we included 90 patients with splenic flexure cancer who were managed and subsequently followed-up in the period from February 2017 to February 2020. Cases were operated in General Surgery department of the Faculty of Medicine of the Zagazig University hospitals. Cases were divided into 3 groups. Each group included 30 patients in order to compare 3 surgical techniques: segmental resection, extended left hemicolectomy, and extended right hemicolectomy.

Inclusion Criteria

Patients with proven diagnosis of splenic flexure cancer stage I to III who underwent curative resection.

Patients with complete medical files.

Patients who accepted to be included in the study.

Exclusion Criteria

Patients with distant metastases, synchronous or metachronous colon cancer, palliative or emergency resection, and patients who received preoperative therapy were excluded.

Finally, we included ninety patients with splenic flexure cancer who were divided into 3 equal groups each group included 90 patients who were managed by one of the 3 different techniques.

Preoperative Workup

Complete physical examination, colonoscopy, biopsy for histopathological confirmation of the diagnosis, computed tomography (CT) of the whole body, and assessment of serum levels of carcinoembryonic antigen.

The following patient characteristics were recorded: age, gender, year of surgery, surgical management approach, and resection type

Operative Data

The following operative data were recorded: operative time, amount of blood loss, intraoperative complications, and operative mortality.

Postoperative Data

The following postoperative data were recorded: duration hospital stay, postoperative complications, 30-day morbidity and mortality.

Histopathological Evaluation

Histopathological subtype, grade, stage, number of dissected lymph nodes, and number of lymph nodes invaded by the cancer were recorded.

We used the 7th edition of the American Joint Committee on Cancer for cancer staging.⁷

Follow-up Data

Most patients were followed-up for 3 years for the detection of disease recurrence, distant metastases, disease progression, progression-free survival, and overall survival rate. The end of the follow-up period was in February 2020.

The follow-up was performed every 4 months in the 1st 2 years, then every 6 months in the 3rd year.

Routine follow-up included complete physical examination and evaluation of the carcinoembryonic antigen.

Colonoscopy and whole-body CT were performed annually.

In case of suspected metastasis or recurrence, positron emission tomography (PET-CT) scan, bone scan, and magnetic resonance imaging (MRI) were performed.

Local recurrence is defined by radiological and histopathological confirmation of cancer in the bowel wall or in the lymphatic drainage area in the site of the primary tumor.

Distant recurrence is defined by radiological and histopathological confirmation of cancer in the liver, the peritoneum, in nonregional lymph nodes, or in distant organs such as the lung or bone.

We calculated the progression-free survival rate from the time of surgery to the time of occurrence of recurrence of the tumor or of distant metastases. We calculated the overall survival rate from the time of surgery to the time of death of the patient.

Ethical approval was obtained from the local ethical committee of the Faculty of medicine of the Zagazig University.

Consent to be included in the present study was obtained from the included patients.

Surgical Techniques

All included patients have received antibiotics and antithrombotics as prophylactic perioperative therapies, but they have not received any mechanical preparation of the bowel.

For the group of patients who underwent extended right hemicolectomy, we have resected the ascending colon, the transverse colon, and part of the descending colon in addition to dissection of regional lymph nodes with ligation of the right colic, the ileocolic, the middle colic, and the left colic vessels at their origins. Then, we performed an ileocolic end-to-side mechanical anastomosis.

For the group of patients who underwent extended left hemicolectomy, we have resected the segment of the colon located between the colorectal junction and the left third of the transverse colon, with excision of the regional lymph nodes, and performed ligation of the left branch of the middle colic and the inferior mesenteric vessels at their origins. We have restored intestinal continuity by mechanical colorectal side-to-end anastomosis.^{8,9}

For the group of patients who underwent segmental splenic flexure resection, we have resected the colonic segment that is found between the distal part of the transverse colon and the first part of the descending colon. We have resected regional lymph nodes and ligated the left branch of the middle colic vessels, of the left colic vessels, and of the inferior mesenteric vein.¹⁰

We have restored intestinal continuity by mechanical colocolic side-to-end anastomosis

Usually, a mechanical side-to-end colocolic anastomosis was performed. We have resected the colon in addition to excision of the regional mesocolon.¹¹

Patients with radiological preoperative confirmation of vascular or regional lymph nodes involvement by malignancy and patients with larger tumor size were more liable to undergo extended resection, either right or left. En-bloc resection of adjacent organs was performed in case of malignant or inflammatory involvement.¹²

Statistical Analysis

IBM SPSS Statistics for Windows version 24 (IBM Corp., Armonk, NY, USA) was used for statistical analysis of the collected data. A p -value ≤ 0.05 was considered as a statistically significant difference, and $p < 0.001$ was considered highly significant. Kaplan and Meier survival curves were used to assess time to death and time to recurrence of the tumor.

Results

The present study included 90 patients who underwent surgical excision of splenic flexure cancer: we performed extended right hemicolectomy in 30 (33.3%), extended left hemicolectomy in 30 (33.3%), and segmental resection of the splenic flexure in 30 (33.3%).

Preoperative Results

Demographics and basic findings about the patients are shown in ►Table 1.

No statistically significant differences were found between the different groups of patients regarding baseline findings.

Operative Results: ►Tables 1 and 2

The operative time was ~ 125 (100–150) minutes in the extended right hemicolectomy group, and 105 (100–150) minutes in both the extended left hemicolectomy group and the segmental resection of the splenic flexure group ($p < 0.001$).

We performed multiorgan resection in 7.5% of all included patients in the extended right hemicolectomy group, in 7.5% of the extended left hemicolectomy group, and in 10.0% of the segmental resection of the splenic flexure group.

We have reported no colon perforation from the cancer or from the surgical procedures.

We have found no statistically significant differences between the three included groups regarding operative findings (►Table 2).

Postoperative Results

The duration of the postoperative hospital stay was 7 (5–9) days for most patients.

The immediate postoperative period was uneventful and there were no significant differences among the studied groups regarding postoperative complications (►Table 2).

Histopathological Results

Most cases were diagnosed as conventional adenocarcinoma of the colon (NOS) while of patients was diagnosed with mucoid carcinoma.

Cancer-free surgical margins were found in 114 (95.0%) patients, correct lymphadenectomy with number of dissected lymph nodes was found in all patients, and there were no significant differences among the studied groups regarding histopathological findings.

The number of dissected lymph nodes was 24 (10–28) in the extended right hemicolectomy group, 20 (10–27) in the

Table 1 Correlations between the three studied surgical techniques regarding demographic and operative findings of included patients

Clinical characteristics of the patients		Management surgical techniques						Total		p-value
		Segmental resection		Extended right hemicolectomy		Left hemicolectomy				
		n	%	n	%	n	%	n	%	
Age (years old)*		55 (29–80)		55 (29–80)		55 (29–80)		55 (29–80)		1
Gender	Female	14	35.0%	14	1	14	35.0%	42	35.0%	1
	Male	26	65.0%	26	1	26	65.0%	78	65.0%	
Tumor size	≤ 5 cm	25	62.5%	25	1	25	62.5%	75	62.5%	1
	> 5 cm	15	37.5%	15	37.5%	15	37.5%	45	37.5%	
Histopathological subtype	Conventional adeno carcinoma	30	75.0%	29	72.5%	29	72.5%	88	73.3%	0.958
	Muroid carcinoma	10	25.0%	11	27.5%	11	27.5%	32	26.7%	
DUKE stage	A	12	30.0%	12	30.0%	12	30.0%	36	30.0%	1
	B	11	27.5%	11	27.5%	11	27.5%	33	27.5%	
	C	17	42.5%	17	42.5%	17	42.5%	51	42.5%	
Stage	I	12	30.0%	12	30.0%	12	30.0%	36	30.0%	0.771
	II	17	42.5%	14	35.0%	12	30.0%	43	35.8%	
	III	11	27.5%	14	35.0%	16	40.0%	41	34.2%	
Lymph node metastasis	No	29	72.5%	26	65.0%	24	60.0%	79	65.8%	0.495
	Yes	11	27.5%	14	35.0%	16	40.0%	41	34.2%	
Number of lymph nodes harvested*		15 (9–20)		24 (10–28)		20 (10–27)		20 (9–28)		<0.001 ^f
Grade	I	11	27.5%	11	27.5%	11	27.5%	33	27.5%	1
	II	26	65.0%	26	65.0%	26	65.0%	78	65.0%	
	III	3	7.5%	3	7.5%	3	7.5%	9	7.5%	
Multiorgan resection	No	36	90.0%	37	92.5%	37	92.5%	110	91.7%	0.897
	Yes	4	10.0%	3	7.5%	3	7.5%	10	8.3%	
Margin status	R0	38	95.0%	38	95.0%	38	95.0%	114	95.0%	1
	R1	2	5.0%	2	5.0%	2	5.0%	6	5.0%	

All variables were compared using the chi-squared X^2 test, except (*) in which the Mann-Whitney test was used.

^fpost-hoc analysis for segmental resection versus extended right hemicolectomy, segmental resection versus left hemicolectomy, and left hemicolectomy versus extended right hemicolectomy (all $p < 0.001$)

extended left hemicolectomy group, and 15 (9–20) in the segmental resection group (►Table 3).

There was a statistically significant difference in the number of dissected lymph nodes among the 3 studied groups, with a higher number of lymph nodes in the extended right hemicolectomy group ($p < 0.001$) (►Table 2).

Oncologic and Follow-up Data: ►Table 3, ►Fig. 1

The follow up time was of ~ 36 months.

During the follow-up period, we have found no statistically significant differences among groups regarding local recurrence, distant recurrence, disease progression, recurrence free survival rate, progression free survival rate, and overall survival rate.

Discussion

There is no established method of management of splenic flexure cancer due to incomplete understanding of dual lymphatic drainage of this location, which is related to both the superior and the inferior mesenteric vessels.^{3,4,13}

Griffiths¹⁴ showed that the splenic flexure region is supplied by the terminal branches of the left colic artery in 89% of cases and by the middle colic branch of the superior mesenteric artery in 11%.

Nakagoe et al.¹⁵ showed that most lymph nodes that proved to be positive for metastatic spread were found to be located along the left colic artery and the paracolic arcade. Vasey et al.¹⁶ concluded that splenic flexure lymphatic drainage was directed toward the left colic vessels in 96%

Table 2 Correlations between the three studied surgical techniques regarding postoperative findings of included patients

Postoperative data		Surgical management technique						Total		p-value
		Segmental resection		Extended right hemicolectomy		Left hemicolectomy				
		n	%	n	%	n	%	n	%	
Duration of hospital stay, days*		7 (5–9)		7 (5–9)		7 (5–9)		7 (5–9)		0.514
Duration of hospital stay	5	7	17.5%	5	12.5%	4	10.0%	16	13.3%	0.963
	6	11	27.5%	9	22.5%	8	20.0%	28	23.3%	
	7	9	22.5%	10	25.0%	12	30.0%	31	25.8%	
	8	7	17.5%	9	22.5%	10	25.0%	26	21.7%	
	9	6	15.0%	7	17.5%	6	15.0%	19	15.8%	
30-day morbidity	No	38	95.0%	38	95.0%	38	95.0%	114	95.0%	1
	Yes	2	5.0%	2	5.0%	2	5.0%	6	5.0%	
30-day mortality	No	39	97.5%	39	97.5%	39	97.5%	117	97.5%	1
	Yes	1	2.5%	1	2.5%	1	2.5%	3	2.5%	
Operative time (minutes)*		105 (90–150)		125 (100–150)		105 (100–150)		110 (90–150)		<0.001 [‡]
Operative complications	0	38	95.0%	38	95.0%	38	95.0%	114	95.0%	1
	1	2	5.0%	2	5.0%	2	5.0%	6	5.0%	
Postoperative complications	0	35	87.5%	36	90.0%	36	90.0%	107	89.2%	0.917
	1	5	12.5%	4	10.0%	4	10.0%	13	10.8%	
Relapse	No	32	80.0%	32	80.0%	32	80.0%	96	80.0%	1
	Yes	8	20.0%	8	20.0%	8	20.0%	24	20.0%	
Death	No	36	90.0%	35	87.5%	36	90.0%	107	89.2%	0.917
	Yes	4	10.0%	5	12.5%	4	10.0%	13	10.8%	

All variables were compared using the chi-squared X^2 test, except (*) in which the Mann-Whitney test was used.

[‡]post-hoc analysis for segmental resection versus extended right hemicolectomy, and left hemicolectomy versus extended right hemicolectomy (all $p < 0.001$); however, segmental resection versus left hemicolectomy $p = 0.464$,

Table 3 Correlations between the three studied surgical techniques regarding progression and survival outcome of included patients

Survival analysis	Total (n)	Events (n)	Censored		Survival rate%	Sig.	Survival time, months		95%CI	
			n	Percent			Mean	Standard error	Lower boundary	Upper boundary
Relapse-free survival										
Segmental resection	40	8	32	80.00%	0.8	0.987	31.85	1.335	29.233	34.467
Extended right hemicolectomy	40	8	32	80.00%	0.8		31.15	1.537	28.137	34.163
Left hemicolectomy	40	8	32	80.00%	0.8		31.15	1.537	28.137	34.163
Overall	120	24	96	80.00%	0.8		31.383	0.851	29.715	33.051
Overall survival										
Segmental resection	40	4	36	90.00%	0.9	0.909	34.2	0.868	32.499	35.901
Extended right hemicolectomy	40	5	35	87.50%	0.875		33.325	1.128	31.115	35.535
Left hemicolectomy	40	4	36	90.00%	0.895		34	0.947	32.143	35.857
Overall	120	13	107	89.20%	0.89		33.842	0.571	32.723	34.961

Abbreviation: CI, confidence interval.

*Median was not reached.

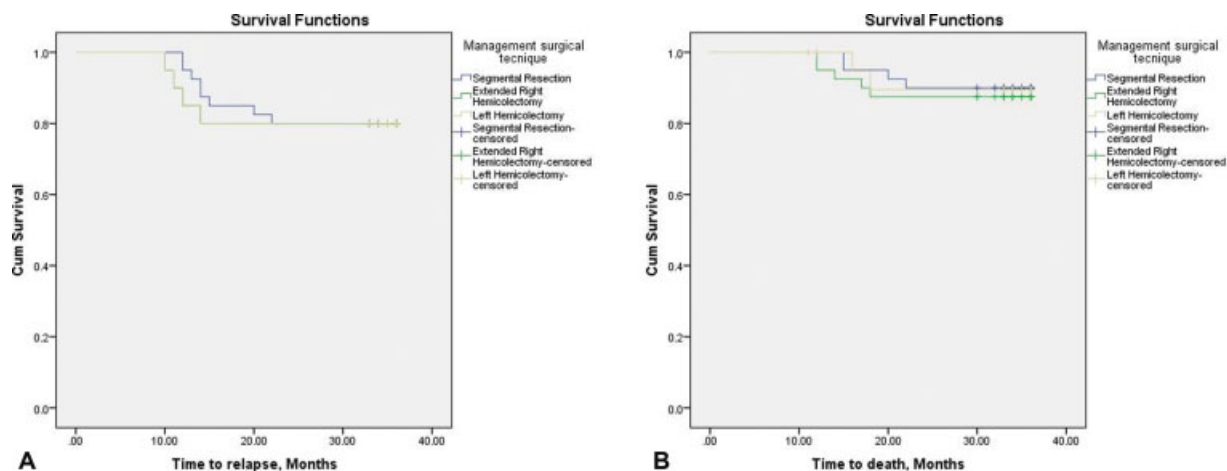


Fig. 1 Survival findings of included patients: (A) time to recurrence and recurrence-free survival rate, (B) time to death and overall survival rate.

of the patients. Some surgeons stated that performing extended hemicolectomy is the best method of management of splenic flexure cancer and consider segmental resection as being less radical to ensure complete removal of all lymph nodes along the branches of the superior mesenteric vessels.^{4,17,18} Other surgeons restricted performing segmental resection for older patients, for patients with comorbid conditions, and as a palliative measure for cases with extensive disease.¹⁹ Other authors showed that extended resection has benefits on survival and is not necessary for all cases.^{3,20} Removal of at least 12 lymph nodes in surgically excised colon cancer is sufficient to ensure radicalism,²¹ which is associated with complete mesocolic excision.^{11,22}

In the present study, we assessed the oncological outcomes of patients with splenic flexure cancer managed by three different surgical approaches – segmental resection, extended left or left hemicolectomy – to detect the best surgical approach of management of this anatomical variant.

Although extended right hemicolectomy produced a higher number of dissected lymph nodes, patients with > 12 dissected lymph nodes were similar between all the 3 groups we have found no statistically significant differences among groups regarding local recurrence, distant recurrence, disease progression, recurrence free survival rate, progression free survival rate, and overall survival rate. Rega et al.¹ performed the first study that compared the three surgical approaches in the management of splenic flexure cancer and found nearly similar results. Our study included a large number of patients operated in more than one hospital, so its results could prove the feasibility of performing segmental resection better than extended resections, with shorter operative time and similar postoperative and long-term outcomes.

Regarding the surgical management of splenic flexure cancer, previous studies have compared only extended right colon resection with extended left colon resection, but they did not clarify long-term and follow-up oncological outcomes.^{18,23,24}

Martínez-Pérez et al.²³ showed that the extent of the surgical procedure does not affect the resection quality or the postoperative outcomes.

With results that were nearly similar to ours, Rega et al.¹ showed that the number of dissected lymph nodes and the rate of negative margins were similar in the three studied groups.

The large number of dissected lymph nodes in the group of patients who were managed by extended right hemicolectomy was due to more extent of colon resection colon with least 3 colonic vascular branches, as has also been reported by other authors.²⁴

In the present study, we made multiorgan resection in included patients which is indicated to made R0 in some cases with large tumor size, we found no statistically significant differences among groups regarding the degree of organ resection. Regarding the degree and number of cases that underwent organ resection, similar results were reported by Rega et al.¹

Additionally, Perrakis et al.²⁵ showed that the rationale for performing splenectomy alone or in addition to distal pancreatectomy is the presence of large number of metastatic lymph nodes in the greater curvature of the stomach, in the head of the pancreas, or in the inferior part of the pancreas.

Regarding operative safety, we have observed no significant difference in the safety, by complication rates, or in the severity of complications among the three studied techniques.

Moreover, we found no statistically significant differences between groups regarding the survival rates of the patients who were followed-up.

Generally, for the adequate management of colon cancer sharp dissection of tissue planes and giving resected tissues having intact mesocolic fascia that surrounded tumor draining lymphatics.

Performing segmental resection of carcinoma of the splenic flexure allows the removal of the left colic, left branch of middle colic lymphatics, ensuring removal of most of lymphatic drainage of colon cancer located in the splenic flexure.

Multiorgan resection was performed in 3 (7.5%) of all included patients of the extended right hemicolectomy group, in 3 patients (7.5%) of the extended left hemicolectomy group, and in 4 patients (10.0%) of the segmental resection of the splenic flexure group.

Due to the prospective nature of the present study, we selected randomly the procedure to be performed.

Conclusion

Collectively, we showed that segmental resection of splenic flexure is surgically and clinically suitable for the adequate management of operable cases of carcinoma of the splenic flexure in Egyptian patients, and that the clinical, surgical, survival or oncological benefits of extended surgery do not surpass those of segmental resection. Moreover, segmental resection allows adequate removal of lymph drainage.

Strengths of the Present Study

One of the strengths of the present study is its prospective nature. Another is that the study was performed on a large number of Egyptian patients with cancer of the splenic flexure, which is a single anatomical subtype of colon cancer. Also, the long follow-up period, which allowed adequate reporting of the results.

Limitations of the Present Study

Its monocenter nature.

Recommendations

We recommend performing large scale, multicenter, prospective, and randomized studies to prove our data regarding the surgical management of splenic flexure cancer.

Conflict of Interests

The authors have no conflict of interests to declare.

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