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Role of Hydro-Dissection Facilitated Monopolar Cauterization Dissection Technique on Separation of the Greater Omentum From the Superior Layer of the Transverse Mesocolon During D2 Radical Gastrectomy

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Adequate separation of the omentum from the transverse colon mesentery, during D2 radical gastrectomy, is usually difficult and often time-consuming due to anatomic variations. The aim of this prospective study was to compare the electrocautery dissection technique with hydrodissection-facilitated electrocauterization for the separation of the greater omentum from the superior layer of the transverse mesocolon in gastric cancer patients undergoing D2 radical gastrectomy. The time taken to separate the greater omentum from the superior layer of the transverse mesocolon, and the number and extension of iatrogenically-created mesocolonic defects were assessed. Forty patients were prospectively randomized into 2 groups. Separation of the greater omentum from the superior layer of the transverse mesocolon was achieved in Group I (n=20) patients by the monopolar cauterization dissection technique whereas in Group II (n = 20) patients by the hydrodissection-facilitated monopolar cauterization. No significant difference was found between the 2 groups in terms of age, gender, body mass index (BMI), type of surgical technique, or the number of resected lymph nodes ($P > 0.05$). The difference between the 2 dissection techniques was not statistically significant when compared according to the number of iatrogenic mesocolonic defects, extension of

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the defects, or the time period required for the separation of greater omentum from the superior layer of the transverse mesocolon ($P > 0.05$). The overall survival was not significantly different between the 2 dissection techniques ($P > 0.05$). Hydrodissection is a safe technique that can be applied as an adjunct to electrocauterization to facilitate the dissection in the correct plane during resection of the mesogastrium.

Key words: D2 radical gastrectomy – Mesogastrium – Electrocauterization – Hydrodissection – Greater omentum – Transverse mesocolon

Adequate separation of the omentum from the transverse colon mesentery is usually difficult due to anatomic variations and is often time-consuming, which, in turn, requires endurance. It is now accepted, both in western and eastern countries, that D2 resection decreases locoregional recurrence and prolongs survival.[1,2] According to the Japanese gastric cancer treatment guidelines 2010 (third version); bursectomy should be considered as an integral component of a standard D2 dissection in gastric cancers, particularly when the serosa is invaded (T3 or T4A stage).[3,4] However, there is limited data, and controversy still exists regarding the rationale of complete versus partial removal of the greater omentum as a part of radical subtotal or total gastrectomy on postoperative outcome, local recurrences and long-term survival in patients with gastric cancer.[5,6] Further, no data exists in the literature concerning the definition of an adequate and standard dissection technique for neither the separation of the omentum from the transverse colon mesentery nor a comparative study of different dissection techniques. The aim of the present study was to compare, prospectively, the electrocautery dissection technique with the hydrodissection facilitated electrocauterization technique in gastric cancer patients undergoing D2 radical gastrectomy. The duration required for the separation of the greater omentum from the superior layer of the transverse mesocolon, the number and extension of developed iatrogenic mesocolonic defects, and postoperative outcome were considered in either technique.

Material and Methods

Between February 2010 and December 2010, 40 patients who underwent D2 radical gastrectomy for gastric carcinoma in the Gastroenterological Surgery Clinic of Turkey Yuksek Ihtisas Teaching and Research Hospital were included in the study. The patients were prospectively randomized into 2 groups of 20 patients each. Each group was assigned a dissection technique for the separation of the greater omentum from the superior layer of the transverse mesocolon.

- Group I (GI; n = 20); monopolar cauterization
- Group II (GII; n = 20); hydrodissection-facilitated monopolar cauterization

Selection of the patients for randomization was performed after abdominal exploration to consider which individuals were suitable for the study. Patients with previous upper gastrointestinal surgery and or an unresectable mass; patients with advanced disease in which the tumor had invaded the transverse mesocolon; those eligible for palliative surgery only; and those requiring additional organ resection were not included in the study.

Surgical technique

The operations were carried out by 7 gastrointestinal surgeons, each with previous experience of performing over 100 gastrectomies. The surgeons are subdivided as senior (n = 3, having experience of gastrointestinal surgery over 5 years) or junior surgeon (n = 4, having experience of gastrointestinal surgery fewer than 5 years). Antibiotic prophylaxis was applied during anesthesia induction using 1 g cephalosporin (Sefazol, Mustafa Nevzat Ilac Sanayi AS, Istanbul, Turkey). After an upper abdominal midline incision, an explorative laparotomy was performed. In the absence of distant metastasis or invasion of adjacent organs, the patient was included in the study and randomization was performed using lots. In both the monopolar cauterization group and hydrodissection-facilitated monopolar cauterization group, the greater omentum was separated after a Kocher maneuver from the superior layer of the transverse mesocolon. The monopolar cauterization was applied in spray mode with a frequency of 30 kHz. In the hydrodissection-facilitated monopolar cauterization group, hydro-

dissection was performed during electrocauterization by intermittent vaporizing saline solution (0.9% NaCl) on the dissection planes using 20 mL injection syringe with 21-gauge needle. The time period required for the separation of the greater omentum from the superior layer of the transverse mesocolon was recorded until the dissection reached the inferior border of the pancreas. The number and size of the iatrogenic defects that occurred during dissection were noted, and the total defect area was calculated by adding all defects after multiplying the length with the width of each one. Dissection for the separation of the omentum from the transverse colon mesentery terminated when the inferior border of the pancreas was reached (Fig. 1). Thereafter, a standard D2 dissection continued for each patient.

Statistical analysis

Data analysis was performed using SPSS for Windows, version 11.5 (SPSS Inc, Chicago, Illinois). Shapiro-Wilk test was used to determine whether the distributions of metric discrete and continuous variables were normal or not. Metric discrete and continuous variables were shown as mean ± standard deviation (SD) or median (min-max), where applicable. Categoric data was expressed as number of cases and percentages. While the mean differences between groups were compared using Student's *t* test, Mann-Whitney U test was used to compare median values. Categoric data was analyzed by Pearson's chi-squared or Fisher's exact test, where appropriate. Overall survival time was defined as time from diagnosis to death or last contact. Overall survival (OS) rates were computed by the method of Kaplan–Meier and were compared using the log-rank test. A *P* value less than 0.05 was considered statistically significant.

Fig. 1 The image shows transverse mesocolon after separation of the omental layers from mesentery.

Results

Twenty-two patients underwent distal subtotal gastrectomy, and the remaining 18 patients had a total gastrectomy. Twenty-eight patients were operated by junior surgeons whereas 12 patients were operated by senior surgeons. The mean age was 62.6 ± 8.9 years in the monopolar cauterization used group (Group I) and 56.6 ± 11.4 years in the hydrodissection facilitated monopolar cauterization used group (Group II). Thirty-one patients were male, and 7 patients were female. The mean body mass index (BMI, kg/m^2) was 24.5 ± 4.4 in the monopolar cauterization used group (Group I) and 24.2 ± 3.6 in the hydrodissection-facilitated monopolar cauterization used group (Group II). The median number of resected lymph nodes was 31 (min-max; 12 to 52) in the monopolar cauterization used group (Group I), whereas 36 (min-max;14 to 73) in the hydrodissection-facilitated monopolar cauterization used group (Group II). There was no significant difference between the 2 groups in terms of age, gender, body mass index (BMI), type of surgical technique, and the number of resected lymph nodes ($P > 0.05$; Table 1).

Demographic data and patients' characteristics of the groups are listed in Table 2 and Table 3, respectively. In the monopolar cauterization used group (Group I); 12 patients underwent radical

Table 1 Patient's demographic data and characteristics

Variables	Group I (n = 20)	Group II (n = 20)	*P* value
Age	62.6 ± 8.9	56.6 ± 11.4	0.072
Gender			0.127
Male	18 (90%)	13 (65%)	
Female	2 (10%)	7 (35%)	
BMI (kg/m^2)	24.5 ± 4.4	24.2 ± 3.6	0.783
Type of surgical technique			0.525
DSG	12 (60%)	10 (50%)	
TG	8 (40%)	10 (50%)	
Number of resected lymph nodes	31 (12–52)	36 (14–73)	0.758

TG, total gastrectomy; DSG, distal subtotal gastrectomy; BMI, body mass index.

Table 2 Demographic data of the patients who underwent the monopolar electrocauterization technique (Group I)

Group I (n)	Number of defects	Total extension of defect area (cm^2)	Time interval for dissection procedure (minutes)	Age	Gender	BMI (kg/m^2)	Surgical procedure	Number of resected lymph nodes (n)
1	2	4.09	27	68	M	32.4	DSG	17
2	3	18.48	35	56	M	19.6	TG	31
3	2	6.3	35	45	M	20.1	DSG	25
4	2	4.4	25	64	M	22.1	TG	34
5	0	0	45	57	M	20.2	DSG	34
6	1	37.82	35	62	M	25.4	DSG	25
7	1	1.2	30	74	M	27.4	DSG	18
8	0	0	60	59	M	30.2	DSG	52
9	3	2.38	30	77	M	20.7	TG	44
10	1	1.8	25	53	M	18.3	DSG	24
11	2	0.66	40	53	M	18.7	DSG	51
12	0	0	35	78	M	31.1	DSG	27
13	0	0	70	53	M	26.1	TG	51
14	0	0	45	63	F	23.3	DSG	12
15	1	9.3	50	69	M	25.8	TG	31
16	2	8.55	30	67	M	21.0	TG	36
17	0	0	45	71	M	29.4	DSG	21
18	0	0	60	54	F	28.4	TG	37
19	1	0.25	45	64	M	22.9	DSG	34
20	0	0	25	66	M	28	TG	15

TG, total gastrectomy; DSG, distal subtotal gastrectomy; BMI, body mass index.

distal subtotal gastrectomy and the remaining 8 patients faced radical total gastrectomy, whereas 10 patients of the hydrodissection-facilitated monopolar cauterization used group (Group II) underwent radical subtotal gastrectomy and 10 patients, radical total gastrectomy. A minimum of 12 lymph nodes was resected in each group.

The difference between the 2 dissection techniques was not statistically significant when compared according to the number of iatrogenic mesocolonic defects, extension of the defects, and the time period required for the separation of the omental layers from the transverse mesocolon ($P > 0.05$; Table 4).

In overall, the mean survival was 44.8 months (95% CI: 38 to 51.6). The 1-year survival rate was 85%, 2-year survival rate was 70%, and 4-year survival rate was 70%, respectively. The overall survival was not significantly different when compared the 2 dissection techniques ($P = 0.985$). The occurrence of iatrogenic mesocolonic defects during dissection had no significant effect on survival ($P = 0.857$). The overall survival was also not significantly affected whether the surgery was made by a senior or junior surgeon ($P = 0.624$; Table 5). However, iatrogenic mesocolonic defects occurred in 3 of 12 operations (25%) made by senior surgeons, and in 25 of 28 operations (89.2%) made by junior surgeons.

Discussion

Gastric cancer is a mortal disease with a high recurrence rate. Surgery with R0 resection seems to be the main curative treatment while the effectiveness of chemotherapy regimens on disease progression is still not efficacious.[7] In the study by Gunderson and Sosin from Minnesota University, recurrence was observed in 86 of 109 patients operated on for gastric cancer (80%). Of these, 54% of recurrences developed via peritoneal implantation, and 25.6% were locoregional.[8] In another study from the Massachusetts Hospital consisting of 130 gastric cancer patients, locoregional metastasis occurred in 16% of the patients, distant metastasis in 30%, and both locoregional and distant metastasis in 22%, respectively.[9] In the study by Wu *et al*, 611 patients underwent curative radical gastric resection. Of these, 76.1% died under follow-up due to tumor recurrence, and locoregional recurrence made up 44.9% of all recurrences.[10] A strong association was observed between the tumor depth in the gastric wall (T stage) and locoregional metastasis.[11] Locoregional metastasis usually occurs at the anastomotic site; in perigastric lymph nodes; around the hepatoduodenal ligament; in the gastric remnant; in celiac axis; in the duodenal stump; and in adjacent organs.[10]

Table 3 Demographic data of the patients who underwent the hydrodissection-facilitated monopolar cauterization technique

Group II (n)	Number of defects	Total extension of defect area (cm^2)	Time interval for dissection procedure (minutes)	Age	Gender	BMI (kg/m^2)	Surgical procedure	Number of resected lymph nodes (n)
1	1	4.4	20	69	F	24	TG	35
2	3	3.2	35	55	F	20.3	TG	38
3	3	11.7	60	52	F	30.1	DSG	36
4	1	1.5	75	70	M	20.4	T.G	14
5	1	1.3	35	54	M	29.3	DSG	18
6	1	1.44	45	47	M	29.4	DSG	18
7	1	2.5	40	52	M	19.6	DSG	37
8	1	0.25	55	39	F	22.5	DSG	38
9	3	2.7	45	45	M	24.4	DSG	16
10	1	4.4	20	54	M	21.2	DSG	17
11	2	0.94	30	61	M	27.5	TG	47
12	2	1.6	20	62	M	25.1	DSG	16
13	0	0	120	70	M	21	TG	51
14	0	0	45	47	F	19.5	TG	73
15	2	2.3	75	50	M	29	TG	37
16	2	16.15	25	61	M	27.7	TG	48
17	2	23.04	28	72	F	23.3	DSG	47
18	0	0	45	60	F	26.2	TG	18
19	0	0	45	78	M	21.3	TG	29
20	3	1.5	45	35	M	22.2	DSG	19

TG, total gastrectomy; DSG, distal subtotal gastrectomy; BMI, body mass index.

The chief reason for locoregional recurrence is the failure of D2 radical gastrectomy. To prevent or minimize this adverse result, the anatomic definition and surgical plane of the mesogastrium should be determined; this is the key to an adequate D2 dissection. The mesogastrium is the portion of the primitive mesentery, which encloses the stomach and from which the greater omentum develops.[12] Gong *et al* called the mesogastrium "the fifth route of metastasis" in gastric cancer after hematogeneous spread, lymphatic drainage, direct invasion to adjacent organs, or peritoneal implantation due to serosal involvement.[13] The mesogastric fascia is the embryologic-anatomic equivalent of Treitz's fascia, pancreatic retro-head, and Toldt's retrocolic fascia, of which it is a structural continuation. As a consequence, the plane of the surgical mesogastrium should include the gastrohepatic ligament, hepatoduodenal ligament, hepatopancreatic folds, splenic and pancreatic folds, gastrophrenic ligament, gastrosplenic ligament, gastrocolic ligament (supracolic omentum), and the omentum.[14]

The rationale of complete or partial omentectomy as a part of D2 radical gastrectomy is still a matter of debate.[15–17] In the comparative studies by Kim M.C. *et al*[18] and Kim D.C. *et al*,[19] it is pointed out that partial omentectomy is safe and practical and can be preferred to total omentectomy in early gastric cancers or in advanced cancers without serosal involvement. However, the patient populations in these series are small and no data exists regarding the long term results. Further, advanced gastric cancer patients with serosal involvement are not included. Now, a randomized phase II trial of omentum-preserving gastrectomy versus gastrectomy including complete omentectomy is being conducted in Japan to evaluate the impact of omentectomy for advanced gastric cancer on patient survival.[20]

Our standard approach to curable gastric cancers is D2 radical gastrectomy, where we consider

Table 4 Comparison of the intraoperative findings related to the dissection techniques according to the groups

Variables	Group I (n = 20)	Group II (n = 20)	*P* value
Number of the defects			0.253
None	8 (40%)	4 (20%)	
1 defect	5 (25%)	7 (35%)	
2 defects	5 (25%)	5 (25%)	
3 defects	2 (10%)	4 (20%)	
Extension area of the defect (cm^2)	0.9 (0–37.8)	1.6 (0–23)	0.512
Time period for the omental dissection (minute)	35 (25–70)	45 (20–120)	0.602

Table 5 Overall survival results

		Survival rates (%)			Mean life expectancy		
	n	1-year	2-year	4-year	(95% confidence interval)	Log-Rank	*P* value
Groups						0.0004	0.985
Monopolar cauterization group	20	85.0	70.0	70.0	44.6 (34.7–54.4)		
Hydrodissection facilitated monopolar cauterization group	20	85.0	70.0	70.0	44.6 (35.3–53.8)		
Defect						0.0325	0.857
No	12	91.7	66.7	66.7	41.8 (30.0–53.6)		
Yes	28	82.1	71.4	71.4	45.3 (37.2–53.4)		
Surgeon						0.2399	0.624
Junior	28	82.1	67.9	67.9	42.1 (34.3–50.0)		
Senior	12	91.7	75.0	75.0	47.2 (35.4–59.0)		
Overall	40	85.0	70.0	70.0	44.8 (38.0–51.6)	-	-

complete resection of the omentum whenever possible. We traditionally use the monopolar electrocauterization during dissection for the separation of the omentum from the transverse colon mesentery. Alternatively, we use the hydrodissection as an adjunct to monopolar electrocauterization, particularly in thinner patients where fascial planes are sometimes unclear due to fusion of the leaf of the omentum to the mesogastrium. The results of the present study pointed out that type of the dissection technique whether as monopolar cauterization or hydrodissection facilitated monopolar cauterization has no significant effect on postoperative outcome and overall survival. The overall survival rates of the present study after D2 radical gastrectomy are similar to other studies.[6,21,22]

Experience of the surgeon is another important factor for a safe and adequate D2 radical gastrectomy. The high number of removed lymph nodes (Table 1) is a good indicator for the experience and practice of the surgeons who took part in the present study. Although hydrodissection-facilitated monopolar cauterization had no additional benefit to monocauterization technique in shortening the dissection time, on postoperative outcome or overall survival, this may be affected by and dependent on our surgeons' handcraft, whose experience and knowledge is sufficient to understand the anatomic structures and their variations. However, iatrogenic mesocolonic defects occurred much more in operations made by junior surgeons than senior surgeons. Furthermore, we observe the benefit of hydrodissection in junior surgeons particularly in the learning phase for better appreciation of the anatomic fascial planes even when it is much more time-consuming.

Today, the hydrodissection technique is frequently used with success in cataract, urologic, and plastic surgery.[23–25] Further, hydrodissection is also used in laparoscopic surgery as an adjunct to electrocauterization to facilitate the dissection of fascial planes.[26,27] The mechanical benefits of hydrodissection of perforator flaps have been shown by Singhal *et al* with evidence of a reduction in perforator dissection time and difficulty.[28] The results of the present study indicate that hydrodissection, when added to electrocauterization, did not alter significantly the dissection time and occurrence of iatrogenic mesocolonic defects. However, in practice, as hydrodissection infiltrates the serosal layers with saline, it both creates and reveals the correct plane between adherent tissues and subsequently makes separation easier.

There are many methods available to measure the defects in extensive soft wound injuries that are usually used by plastic and reconstructive surgeons. The confidence interval of these methods is similar and one of the simplest methods is to multiply the longest defect diameter with the shortest diameter as we did.[29] In both techniques, blood loss during the dissection of the mesogastrium was too low to allow calculation or comparison.

In conclusion, hydrodissection is a safe technique that can be applied as an adjunct to electrocauterization, which facilitates dissection in the correct plane during resection of the mesogastrium. Although hydrodissection does not have additional benefits in terms of dissection time, postoperative outcome, or overall survival, it can be useful for inexperienced surgeons, especially for those in the learning phase.

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