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D2 Lymphadenectomy and Complete Mesogastric Excision in Gastric Cancer: 5-Year Results from a Single Center

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ABSTRACT

Introduction: Complete mesogastric excision (CME), combined with classical D2 lymphadenectomy (D2LND), ensures the removal of all mesogastric tissue. This procedure aims to reduce local cancer spread and prevent the dissemination of microscopic cancer cells. The aim of this study is to compare CME with conventional D2LND in the treatment of gastric cancer (GC) and to evaluate our five-year results, emphasizing the potential advantages of CME.

Methods: Data on patients who underwent surgery for GC between 2016 and 2021 were collected from the clinical information system. The data from cases undergoing D2 lymph node dissection with CME were compared and retrospectively analyzed.

Results: Among the 76 cases, 41 (54%) underwent D2 dissection in addition to gastric resection, the other while the other 35 (46%) underwent CME. During the three-year follow-up period, recurrence was observed in 12 patients (29.2%) in the D2 dissection group, whereas 4 patients (11.4%) in the CME group experienced recurrence.

Conclusion: By facilitating more extensive lymphadenectomy without increasing postoperative complications, CME may contribute to reducing tumor recurrence. Although preliminary findings support the potential oncological benefits of this technique, further validation through large-scale, multicenter, randomized controlled trials is necessary to establish its definitive clinical utility.

Keywords: Gastric cancer, complete mesogastric excision, lymphadenectomy

Introduction

Except for East Asian countries, where early screening programs are implemented, gastric cancer (GC) is typically diagnosed at an advanced stage (1,2). Therefore, gastrectomy with D2 lymphadenectomy (D2LND) following neoadjuvant therapy remains the standard treatment approach (3,4). However, one of the most significant challenges in these cases is the high recurrence rate. According to studies in the literature, recurrence rates after curative surgery can be as high as 60% (5-8).

In colorectal cancer surgery, Cecil et al. (9) introduced the total mesorectal excision technique, successfully reducing local recurrence rates in rectal cancer from approximately 33% to 10%. Similarly, Hohenberger et al. (10) addressed recurrence in colon cancer by implementing the total mesocolic excision and vascular ligation technique, lowering the five-year recurrence rate from 6.5% to 3.6% and increasing five-year cancer-specific survival from 82.1% to 89.1% in patients undergoing curative resection.

In 2015, Xie et al. (11) introduced the concept of complete mesogastric excision (CME) for GC. The CME technique involves the total removal of the mesogastrium, the connective tissue surrounding the stomach which is considered a potential pathway for cancer cell dissemination. When combined with classical D2LND, CME ensures the complete excision of the mesogastric tissue, aiming to reduce local tumor spread and prevent microscopic cancer dissemination.

Xie et al. (12) reported that the combination of gastrectomy, D2LND, and CME resulted in better short-term outcomes and surgical safety in patients with advanced GC compared to conventional D2LND (13-16). Furthermore, Shinohara et al. (17) and Girnyi et al. (18) proposed that systematic mesogastric excision in GC should align with the surgical principles of total mesorectal excision in rectal cancer and complete mesocolic excision in colon cancer. These researchers advocated for the en bloc resection of the mesogastrium while preserving the relevant vessels in the pancreas and mesogastrium to achieve D2LND based on the CME concept.

Within this framework, despite the anatomical limitations specific to the mesogastrium, D2 gastrectomy can be considered a form of mesentery-based surgery. Similar to total mesorectal excision and complete mesocolic excision, the CME principle is expected to contribute to the standardization of surgical strategies for GC.

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The aim of this study is to compare CME with conventional D2LND in the treatment of GC and to evaluate our five-year results, emphasizing the potential advantages of CME.

Methods

In this study, data from patients who underwent surgery for GC at the Surgical Oncology Clinic of the University of Health Sciences Türkiye, Ümraniye Training and Research Hospital, between June 2016 and 2021, were retrospectively reviewed. The study was approved by the University of Health Sciences Türkiye, Ümraniye Training and Research Hospital Ethics Committee (approval number: 2022/304, date: 29.09.2022).

Patient Selection and Group Classification

Patients included in the study were categorized into two distinct groups based on the surgical technique employed. Those who underwent conventional gastrectomy with standard D2LND were referred to as the control group, while those who underwent gastrectomy with D2LND in conjunction with CME constituted the study group. This classification allowed for a comparative evaluation of the oncological and perioperative outcomes associated with the two surgical approaches.

Study Parameters and Variables

The study comprehensively assessed various preoperative, intraoperative, and postoperative parameters, including age, gender, body mass index (BMI), and American Society of Anesthesiologists (ASA) classification scores. Type of gastrectomy performed (total or subtotal), tumor location (cardia, antrum, corpus), and pathological TNM (pTNM) staging. Chemotherapy and/or radiotherapy may be administered before or after surgery. Operative time, estimated intraoperative blood loss, number of lymph nodes dissected, and achievement of R0 resection (negative surgical margins). Morbidity and mortality rates, occurrence of surgical complications, length of hospital stay, and time to initiation of oral intake are key variables in assessing patient outcomes. Recurrence rates, disease-free survival (DFS), and overall survival (OS).

To ensure the homogeneity of the study cohort and minimize potential confounders, some patients were excluded from the study. The excluded patients were as follows: emergency surgical intervention due to tumor-related complications such as bleeding or obstruction, presence of distant metastases or intraperitoneal peritoneal carcinomatosis at the time of diagnosis, undergoing palliative rather than curative-intent surgery. Incomplete medical records or loss to follow-up within the first postoperative year.

Surgical Technique

The CME procedure was meticulously performed by experienced surgeons who specialize in GC surgery. The technique focused on the en bloc resection of the mesogastrium to minimize the risk of tumor cell dissemination along anatomical lymphovascular pathways. CME was executed in three principal anatomical regions: 1. Lower pyloric region - ensuring precise dissection around the duodenal stump and right gastroepiploic vascular structures. 2. Splenic region - addressing lymphatic drainage pathways associated with the splenic artery and hilum. 3. Upper pancreatic region - preserving critical pancreatic structures while achieving comprehensive lymphadenectomy. Further stratification of the mesogastric dissection areas classified CME into six distinct subgroups: right gastroepiploic, right gastric, left gastric, posterior gastric, left gastroepiploic, short gastric mesentery. The meticulous adherence to these surgical principles was aimed at improving oncological clearance while minimizing perioperative morbidity.

Statistical Analysis

All statistical analyses were performed using SPSS version 20.0 software (IBM SPSS, Inc., Chicago, IL, USA. Continuous variables were presented as mean ± standard deviation for normally distributed data. Categorical variables were summarized using absolute frequencies and percentages. Comparative analyses between the two surgical groups were conducted based on the nature of the variables. A p-value of <0.05 was considered statistically significant in all analyses.

Results

Between June 2016 and 2021, 121 patients were operated on due to GC in our clinic. Among these 121 patients, 45 were excluded due to prior gastric surgery, stage 4 disease, or incomplete data. Consequently, 76 patients were included in the study. Among them, 41 (54%) underwent gastrectomy with D2LND, while 35 (46%) underwent gastrectomy with D2LND combined with CME.

In the gastrectomy + D2LND group, 30 patients underwent total gastrectomy (73%) and 11 patients (27%) underwent subtotal gastrectomy. In the D2 + CME group, total gastrectomy was performed in 28 patients (80%) and subtotal gastrectomy in 7 patients (20%) (p=0.48). The gastrectomy + D2LND group comprised 23 male (56%) and 18 female (44%) patients, while the D2 + CME group included 20 male (57.2%) and 15 female (42.8%) patients (p=0.91).

The mean age was 62.92±7.60 years in the gastrectomy + D2LND group and 61.30±8.12 years in the D2 + CME group (p=0.43). The mean BMI was 24.30±2.83 kg/m^2 in the gastrectomy + D2LND group and 25.23±2.81 kg/m^2 in the D2 + CME group (p=0.27). In terms of age, gender, BMI, ASA scores, surgical method (total/subtotal gastrectomy), tumor location (cardia, antrum, corpus), or pTNM stage (p>0.05), there was not a statistically significant difference between the two groups (Table 1).

In the gastrectomy + D2LND group, total gastrectomy was performed in 28 patients (68.3%), distal gastrectomy in 12 patients (29.3%), and proximal gastrectomy in 1 patient (2.4%). In the D2 + CME group, total gastrectomy was performed in 23 patients (65.7%), distal gastrectomy in 11 patients (31.4%), and proximal gastrectomy in 1 patient (2.9%). R0 resection with negative surgical margins was achieved in all patients in both groups. Positive tumor deposits (TD) were identified in 17 patients (41.4%) in the D2LND group and in 14 patients (40%) in the D2 + CME group (p=0.88). No statistically significant differences were noted between the groups in terms of positive TD rates, number of positive lymph nodes, or postoperative hospital stay (p>0.05).

Although the operation duration was significantly longer in the D2 + CME group compared to the D2LND group [220.40±41.23 minute

Table 1. Demographic datas			
Variable	**Group A (D2LND), (n=41)**	**Group B (D2 + CME), (n=35)**	**p**
Male/female, (n)	23/18	20/15	0.91
Mean age (years)	62.92±7.60	61.30±8.12	0.43
Mean body mass index (kg/m^2)	24.30±2.83	25.23±2.81	0.27
ASA score, n (%)			0.83
ASA I	15 (36.5%)	14 (40%)	
ASA II	12 (29.2%)	11 (31.4%)	
ASA III	9 (21.9%)	7 (20%)	
ASA IV	5 (12.1%)	3 (8.6%)	
Tumor location, n (%)			0.78
Cardia	15 (36.5%)	12 (34.2%)	
Antrum	16 (39.0%)	13 (37.1%)	
Corpus	10 (24.5%)	10 (28.7%)	
Surgical method, n (%)			0.48
Total gastrectomy	30 (73%)	28 (80%)	
Subtotal gastrectomy	11 (27%)	7 (20%)	
Positive tumour deposits, n (%)	17 (41.4%)	14 (40%)	0.88

Group A: Patients underwent gastrectomy + D2LND, Group B: Patients underwent gastrectomy + D2LND + CME. ASA: American Society of Anesthesiologists, D2LND: D2 lymph node dissection, CME: Complete mesogastric excision

Table 2. Intraoperative and postoperative findings			
Variable	**Group A (D2LND), (n=41)**	**Group B (D2 + CME), (n=35)**	**p**
Duration of operation, minute	175.44±51.39	220.40±41.23	**<0.001**
Intraoperative blood loss, mL	130.47±56.64	120.21±47.30	0.43
Mean number of dissected lymph nodes	36.37±14.71	44.15±13.5	**<0.001**
Time to first bowel movement, days	3 (2-4)	3 (2-4)	0.82

Group A: Patients who underwent gastrectomy + D2LND, Group B: Patients who underwent gastrectomy + D2LND + CME. D2LND: D2 lymph node dissection, CME: Complete mesogastric excision

(min.) vs. 175.44±51.39 min., p<0.001], intraoperative blood loss was comparable (120.21±47.30 mL vs. 130.47±56.64 mL, p=0.43). Additionally, the number of harvested lymph nodes was significantly higher in the D2 + CME group (44.15±13.5 vs. 36.37±14.71, p<0.001). The time to first bowel gas passage and initiation of a liquid diet was similar between the groups [D2 group: 3 (2-4) days vs. D2 + CME group: 3 (2-4) days, p=0.82] (Table 2).

According to the complication classification, no significant difference was observed in postoperative complications between the D2LND and D2 + CME groups (p=0.79). No perioperative mortality occurred in either group (Table 3). The most common postoperative complications were pulmonary infections, ileus, and surgical site infections, occurring in 8 patients (19.51%) in the D2LND group and in 7 patients (20%) in the D2 + CME group, with no statistically significant difference between groups (p=0.79).

The mean follow-up period was 36 months. During the three-year follow-up, eight patients (19.5%) in the D2LND group were lost to follow-up, and recurrence was observed in 12 patients (29.2%). In the D2 + CME group, 4 patients (11.4%) were lost to follow-up, and recurrence was detected in 4 patients (11.4%). The local recurrence rate was higher in the D2LND group (29.26%) compared to the D2 + CME group (11.42%), and it was statistically significant (p=0.04) (Table 4).

Table 3. Mortality and morbidity			
Variable	**Group A (D2LND), (n=41)**	**Group B (D2 + CME), (n=35)**	**p**
Clavien-Dindo Classification			0.79
Grade 1	5	4	
Grade 2	3	3	
Grade 3	0	0	
Grade 4	0	0	
Perioperative mortality	0	0	1.00

Group A: Patients underwent gastrectomy + D2LND, Group B: Patients underwent gastrectomy + D2LND + CME. D2LND: D2 lymph node dissection, CME: Complete mesogastric excision

The three-year OS and DFS rates in the D2LND group were 73.1% (30/41) and 68.2% (28/41), respectively. In the D2 + CME group, the 3-year OS and DFS rates were 74.2% (26/35) and 68.5% (24/35), respectively (p=0.88, p=0.97) (Figure 1).

Discussion

Given the high recurrence rates following GC surgery, it is imperative to refine surgical techniques, implement strategies to minimize perioperative cancer cell dissemination, and ensure adherence to

Table 4. Follow-up findings

Variable	Group A (D2LND), (n=41)	Group B (D2 + CME), (n=35)	p
Number of patients lost to follow-up	8 (19.5%)	4 (11.4%)	0.34
Number of patients with recurrence	12 (29.2%)	4 (11.4%)	**0.04**
Overall survival rate	73.1%	74.2%	0.88
Disease free survival rate	68.2%	68.5%	0.97

Group A: Patients underwent gastrectomy + D2LND, Group B: Patients underwent gastrectomy + D2LND + CME. D2LND: D2 lymph node dissection, CME: Complete mesogastric excision

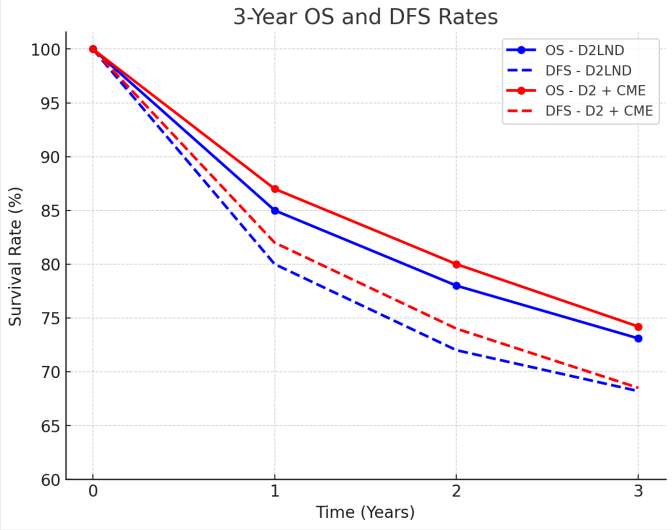

Figure 1. Three-years OS and DFS rates. Group A: Patients underwent gastrectomy + D2LND, Group B: Patients underwent gastrectomy + D2LND + CME, Blue lines: D2LND group (solid line: OS, dashed line: DFS), Red lines: D2 + CME group (solid line: OS, dashed line: DFS)
OS: Overall survival, DFS: Disease-free survival, D2LND: D2 lymp node dissection, CME: Complete mesogastric excision

standardized postoperative treatment and follow-up protocols (19). Recurrence may result from various factors, including lymphatic metastasis, vascular trauma during lymphadenectomy, peritoneal dissemination, and tumor cell infiltration within intramesenteric dissectable layers. Recently, research has increasingly focused on the role of CME in controlling disease progression and metastasis pathways. Xie et al. (11) introduced CME as an adjunct to D2 gastrectomy, conceptualized as the "Table Model," with the primary objective of reducing intraoperative cancer cell dissemination and improving long-term oncological outcomes compared to conventional D2 gastrectomy. While D2 + CME has been associated with a lower presence of free intraperitoneal cancer cells and enhanced DFS, concerns regarding its safety and overall efficacy remain unresolved (13,14).

Xie et al. (19) conducted a randomized controlled trial comparing D2 + CME and conventional D2 gastrectomy in 486 patients. Their findings indicated that D2 + CME was associated with reduced intraoperative blood loss, more extensive lymph node dissection, and superior short-term outcomes, particularly in patients with advanced GC (19). Granieri et al. (20) further demonstrated that CME led to decreased intraoperative blood loss, shorter operative times, earlier return of bowel function, and reduced hospital stays, with no significant differences in postoperative complications. Similarly, Cao et al. (21) observed reduced blood loss in laparoscopic D2 + CME procedures compared to the standard D2 approach. In a retrospective analysis of 599 cases of locally advanced GC treated surgically between 2014 and 2019, Li et al. (22) found no statistically significant difference between D2 and D2 + CME groups regarding mesogastric TD, pathological lymph node counts, or length of hospital stay ($p>0.05$). However, the D2 + CME cohort exhibited reduced intraoperative bleeding, earlier postoperative bowel function recovery, and significantly higher lymph node yields. Importantly, laparoscopic D2 + CME did not increase postoperative complications (22). Our findings align with Li et al. (22) conclusions regarding TD, yet we observed longer operative times in the D2 + CME group. Unlike the studies by Li et al. (22), Cao et al. (21), and Granieri et al. (20), our study found no significant difference in intraoperative blood loss between D2 and D2 + CME groups (120.21±47.30 mL vs. 130.47±56.64 mL, $p>0.05$). Additionally, the time to first bowel movement and liquid diet initiation remained comparable between the groups.

The extent of lymph node dissection is a critical determinant of GC surgical outcomes. Granieri et al. (20) demonstrated that CME facilitated more comprehensive lymphadenectomy compared to conventional D2 gastrectomy. Xie et al. (23) reported a significantly greater lymph node yield with D2 + CME than with standard D2 gastrectomy (34 vs. 27 nodes, respectively). Similarly, Cao et al. (21) reported a median of 31 resected regional lymph nodes in patients undergoing laparoscopic subtotal gastrectomy with D2 + CME. Consistent with these findings, our study observed a significantly higher lymph node yield in the D2 + CME cohort.

Zhao et al. (24) conducted an observational cohort study between 2013 and 2017, comparing D2 and D2 + CME procedures in 855 patients. Their results indicated that D2 + CME was associated with reduced blood loss, higher lymph node dissection counts, and expedited bowel function recovery, suggesting superior short-term outcomes compared to conventional D2 dissection in resectable GC cases (24). Cai et al. (25) examined 323 patients with T1-3N0M0 GC, who underwent D2 + CME (n=185) or standard D2 gastrectomy (n=138) between 2014 and 2018. They reported lower intraoperative blood loss, increased lymph node retrieval, and faster postoperative recovery in the D2 + CME group, with no significant difference in postoperative morbidity (25). Additionally, Li et al. (22) found no significant differences in complication rates between D2 + CME (20.7%) and D2 (19.4%) groups ($p>0.05$). Cao et al. (21) observed a postoperative morbidity rate of 9.3% and no perioperative mortality in patients undergoing D2 + CME, with comparable hospitalization durations to the standard D2 approach. Xie et al. (19) reported prolonged operative times in the D2 + CME cohort but no increase in adverse events. Cai et al. (25) found a significantly lower local recurrence rate in the D2 + CME group ($p=0.031$), with 5-year DFS rates of 95.6% and 90.4% in the D2 + CME and D2 groups, respectively.

Duzkoylu et al. (26) conducted a prospective randomized study in 37 cases, comparing CME with conventional surgical techniques in terms of short-term outcomes. Their findings suggested that CME led to reduced intraoperative blood loss significantly higher numbers of retrieved

lymph nodes, and improved DFS compared to standard D2 gastrectomy, establishing CME as a safe and oncologically advantageous technique (26). Xie et al. (23) further evaluated the impact of D2 + CME on survival in the DCGC01 trial (2014-2018). Among 169 patients in each cohort, recurrence was reported in 50 (29.6%) of the D2 group and 33 (19.5%) of the D2 + CME group (p=0.032) (23). In concordance with existing literature, our study found no statistically significant difference between D2 and D2 + CME regarding the severity of postoperative complications (p>0.05); and no perioperative mortality was reported in either group.

Study Limitations

The primary limitations of this study include its retrospective design and the predominance of comparative data derived from Chinese cohorts. Additionally, the lack of Western and European data on CME, as well as the heterogeneity of cases due to variations in neoadjuvant treatment protocols and demographic characteristics, remains significant constraints.

Conclusion

The integration of CME with D2LND represents a promising advancement in GC surgery. By facilitating more extensive lymphadenectomy without increasing postoperative complications, CME may contribute to reducing tumor recurrence. Although preliminary findings support the potential oncological benefits of this technique, further validation through large-scale, multicenter, randomized controlled trials is necessary to establish its definitive clinical utility.

Ethics

Ethics Committee Approval: The study was approved by the University of Health Sciences Türkiye, Ümraniye Training and Research Hospital Ethics Committee (approval number: 2022/304, date: 29.09.2022).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions: Surgical and Medical Practices - P.Ö.; Concept - P.Ö.; Design - P.Ö.; Data Collection or Processing - P.Ö.; Analysis or Interpretation - P.Ö., Ö.D.; Literature Search - P.Ö.; Writing - P.Ö., Ö.D.

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