

# A Comparative Analysis of Immediate Postoperative Complications Following Total Gastrectomy

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Article history: Received: 15.10.2016 Accepted: 20.12.2016 Published: 30.06.2017

## ABSTRACT

**Introduction:** Total gastrectomy (TG), despite disrupting the continuity of the alimentary tract and accounting for significant postoperative complications, is the procedure of choice for curative resection of gastric carcinoma. The objectives of this study were to report the rate of postoperative complications following TG, to analyze adverse postoperative outcomes, and to determine the safer technique between Roux-en-Y Esophagojejunostomy and Omega Braun TG.

**Materials and Methods:** A retrospective, observational study was conducted among patients diagnosed with gastric carcinoma who underwent TG between January 1st, 2010 and December 31st, 2012 in the Surgery Department of the Bucharest Clinical Emergency Hospital. Descriptive and analytical statistical analysis with parametric and non-parametric tests was carried out using GraphPad, with statistical significance set at  $p < 0.05$ .

**Results:** Seventy-seven patients, aged 37-91 years (average age  $64.1 \pm 11.59$  years), were enrolled in this study. A total of 84 immediate postoperative complications were encountered in 35 patients (47.5%), classified into local ( $n=21$ , 25%) and general complications ( $n=63$ , 75%). Reoperation was necessary in five cases (6.2%), all after Roux-en-Y end-side esophagojejunostomy. Two deaths ( $n=2$ , 2.5%), one after Roux-en-Y and one after Omega-Braun TG, were reported.

**Discussion:** The Roux-en-Y technique had the higher number of complications, both local and general. Omega-Braun TG was associated with a lower number of local complications; however, it was associated with life-threatening complications including hemodynamic instability and multisystem organ failure. A statistically significant correlation between manual anastomosis and mortality was observed.

**Conclusion:** This study deemed Roux-en-Y Esophagojejunostomy the safer procedure. Total gastrectomy is a complex procedure with numerous potential complications, which calls for an improved surgical technique to reduce the postoperative risk.

## KEYWORDS:

Total gastrectomy, immediate postoperative complications, Roux-en-Y total gastrectomy, Omega-Braun total gastrectomy, gastric carcinoma

## INTRODUCTION

Worldwide, gastric cancer is the third leading cause of cancer-related death, preceded only by pulmonary and hepatic cancers. In 2012, 951,000 new cases were diagnosed globally, along with 723,000 deaths worldwide [1]. Total gastrectomy (TG), despite disrupting the continuity of the alimentary tract and accounting for significant postoperative complications, is the procedure of choice for curative resection of gastric carcinoma [2,3]. Total gastrectomy entails surgical removal of the entire stomach, culminating in esophagojejunal anastomosis. Total gastrectomy is indicated for tumors of the proximal third of the stomach or diffusely infiltrative tumors. The two main surgical techniques of TG are Roux-en-Y esophagojejunostomy and Omega-Braun TG [2]. Total gastrectomy accounts for approximately one-third of all gastric resections [4].

Adverse events after TG are scarcely described in literature, mainly due to the lack of a uniform system of reporting postoperative outcomes following TG [5]. Furthermore, the definition of adverse events or complications varies widely among centers due to the lack of a standardized definition of an adverse surgical outcome [6]. Thus, the rate of postoperative complications following TG varies widely among surgical centers, with complication rates ranging between 9% and 46%, and mortality rates ranging from 1.1% to 10.8% [4,5,7].

The objectives of this study were to determine the rate of postoperative complications following TG, to analyze adverse postop-

erative outcomes, and to determine the safer technique between Roux-en-Y Esophagojejunostomy and Omega Braun TG. - Roux-en-Y esophagojejunostomy and Omega-Braun TG.

## MATERIALS AND METHODS

A retrospective, observational study was conducted among patients with gastric cancer who underwent TG over a three-year period between January 1st, 2010 and December 31st, 2012. This study took place at the Bucharest Clinical Emergency Hospital, which is a tertiary referral center. The inclusion criteria comprised a history of TG due to histopathologically confirmed gastric carcinoma during the aforementioned timeframe. This study is a retrospective analysis of prospectively collected data. Patient data including demographics, preoperative, intraoperative, and postoperative parameters were acquired from patient files. Statistical analysis was performed with GraphPad, encompassing descriptive and analytical statistics, with parametric and non-parametric tests and statistical significance set at  $p < 0.05$ .

## RESULTS

Seventy-seven patients, 52 males (67.5%) and 25 females (32.5%), aged 37-91 years, with a mean age of  $64.1 \pm 11.59$  years underwent TG between January 1st, 2010 and December 31st, 2012. The mean age in males was 66 years, compared to 60.3 years in

females; however, no statistically significant difference between genders was found ( $t=2.04$ ). The majority of patients resided in urban areas ( $n=50$ , 64.6%), while 27 (35.4%) lived in a rural setting.

The two surgical techniques of TG employed were Roux-en-Y esophagojejunostomy, in 66 patients (85.7%), and Omega-Braun TG, in 11 patients (14.3%). Preoperative staging revealed that 13 (16.8%) patients presented with locally invasive disease only, 49 (63.6%) patients had nodal disease, and 15 (19.6%) were admitted with distant metastases. Stage III disease (nodal involvement) was the most prevalent stage among participants ( $n=49$ ), accounting for 63.6% of the study population. A more detailed sub-staging system is described as follows: stage IA ( $n=1$ , 1.3%), stage IIA ( $n=4$ , 5.2%), stage IIB ( $n=8$ , 10.4%), stage IIIA ( $n=12$ , 15.6%), stage IIIB ( $n=10$ , 13%), stage IIIC ( $n=27$ , 35.1%), and stage IV ( $n=15$ , 19.4%). Staging was comparable between the 2 groups, with an identical proportion of stage III tumors: 63.6%, while similar rates of distant metastasis were noticed: 18.2% and 19.47% in the Omega Braun and Roux-en-Y Esophagojejunostomy procedures, respectively. With regard to the extent of comorbidities in patients undergoing the 2 procedures, the Charlson Comorbidity Scoring Index was used, with values of 1.25 and 1.45 for Roux-en-Y esophagojejunostomy and for Omega-Braun TG, respectively. Preoperative parameters are further presented in Table 1.

Regarding the extent of lymphadenectomy, 37 (48%) patients underwent D1 lymphadenectomy, and 40 (52%) patients underwent D2 lymphadenectomy. Mechanical anastomosis was performed in 66 (85.7%) patients, of whom 61 (92.4%) underwent Roux-en-Y esophagojejunostomy and 5 (7.6%) Omega-Braun TG. The proportion of mechanical anastomoses was 79.2% (61 per 77 cases) for Roux-en-Y esophagojejunostomy and 45.4% (5 per 11 cases) for Omega-Braun TG. A statistically significant correlation between manual anastomosis and mortality was observed (OR: 0.06, 95%CI: 0.01-0.30,  $p=0.0004$ ).

A total of 25 (32.5%) associated procedures were performed, of which 20 (80%) accompanied Roux-en-Y esophagojejunostomy. Splenectomy was the most frequently performed associated procedure, with a total of 14 cases (18.2%); 12 (85.7%) in Roux-en-Y esophagojejunostomy and 2 cases (14.3%) in Omega-Braun TG. There were several associated procedures carried out along with only one of the two surgical techniques studied: caudal splenopancreatectomy, segmental colectomy, and left adrenalectomy were performed only in the case of Roux-en-Y esophagojejunostomy, while hepatic metastasectomy was performed with Omega-Braun TG. The average operative time was 30 minutes longer for Omega-Braun TG ( $214 \pm 0.9$  minutes) than for Roux-en-Y esophagojejunostomy ( $184 \pm 0.9$  minutes). Intraoperative parameters are further described in Table 2.

A total of 84 immediate postoperative complications were encountered in 35 patients (47.5%), classified into local ( $n=21$ , 25%) and general complications ( $n=63$ , 75%). The local complications included surgical site infection (SSI) ( $n=5$ , 24%), seroma ( $n=5$ , 24%), diarrhea ( $n=4$ , 19%), esophagojejunal fistula ( $n=4$ , 19%), acute postoperative pancreatitis ( $n=2$ , 9.5%), and subphrenic abscess ( $n=1$ , 4.8%), as presented in Table 3. Of the 35 patients who developed postoperative complications, 32 patients underwent Roux-en-Y esophagojejunostomy, with a complication rate of 48.5%. Three of the 11 patients (27.3%) who underwent Omega-Braun TG de-

Tab. I. Preoperative parameters

CHARACTERISTIC	ROUX-EN-Y (N=66)	OMEGA-BRAUN (N=11)	ODDS RATIO (OR)	95% CI	P-VALUE
Gender					
Male	47 (71.2%)	5 (45.5%)	-	-	-
Female	19 (28.8%)	6 (54.5%)			
Mean age	64.1 $\pm$ 11.59	64.1 $\pm$ 11.59	-	-	-
Mean Charlson Comorbidity Index	1.25	1.45			
Staging					
I	1 (1.5%)	0 (0%)			
II	10 (15.2%)	2 (18.2%)	-	-	-
III	42 (63.6%)	7 (63.6%)			
IV	13 (19.7%)	2 (18.2%)			
Distant metastases					
Present	13 (19.7%)	2 (18.2%)	0.02	0.005-	<
Absent	53 (80.3%)	9 (81.8%)		0.13	0.0001
Hemoglobin					
< 12.5 g/dL	50 (88%)	6 (54.5%)	2.60	0.70-	0.15
> 12.5 g/dL	16 (12%)	5 (45.5%)		9.68	
Albumin					
3.5-5 g/dL	35 (53%)	2 (18.2%)	0.19	0.03-	0.04
< 3.5 g/dL	31 (47%)	9 (81.8%)		0.98	

Tab. II. Intraoperative parameters

CHARACTERISTIC	ROUX-EN-Y (N=66)	OMEGA-BRAUN (N=11)	ODDS RATIO (OR)	95% CI	P-VALUE
Operation type					
Major	20 (30.3%)	5 (45.5%)	0.52	0.514-1.91	0.32
Major complex	46 (69.7%)	6 (54.5%)			
Lymphadenectomy					
D1	31 (47%)	6 (54.5%)	0.73	0.20-2.65	0.64
D2	35 (53%)	5 (45.5%)			
Anastomosis					
Manual	75 (7.6%)	6 (54.5%)	0.06	0.01-0.30	0.00004
Mechanical	61 (92.4%)	5 (45.5%)			
Mean operative time	214 $\pm$ 0.9	184 $\pm$ 0.9	-	-	-

veloped a postoperative complication; however, when the two group were compared, no statistically significant difference was seen (OR: 0.39, 95% CI: 0.09-1.63,  $p=0.20$ ). Moreover, no statistically significant correlations were observed between specific local complications and the type of TG performed.

The general complications included secondary anemia ( $n=20$ , 31.7%), postoperative fever without apparent infection ( $n=14$ , 22.2%), cardiorespiratory arrest ( $n=4$ , 6.3%), multisystem organ failure (MSOF) ( $n=3$ , 4.7%), atrial fibrillation (AF) ( $n=2$ , 3.1%), hemodynamic instability ( $n=2$ , 3.1%), pericarditis ( $n=1$ , 1.6%), pericardial effusion ( $n=1$ , 1.6%), and respiratory arrest ( $n=1$ , 1.6%). Statistically significant correlations were observed in the case of atrial fibrillation ( $p=0.0004$ ) and hemodynamic instability ( $p=0.0004$ ) – both complications were specifically associated with Omega-Braun TG (Tables 4 and 5).

Respiratory complications included pleural effusion ( $n=6$ , 9.5%), bronchopneumonia ( $n=4$ , 6.3%), atelectasis ( $n=3$ , 4.7%), and tracheal aspiration ( $n=1$ , 1.6%), as presented in Table 6. No statisti-

**Tab. III.** Local complications encountered according to TG type

TG PROCEDURE	SEROMA	SSI	DIARRHEA	FISTULA	ACUTE POSTOPERATIVE PANCREATITIS	SUBPHRENIC ABSCESS
Roux-en-Y	5	5	4	4	2	1
Omega TG	-	-	-	-	-	-
Total	5	5	4	4	2	1
Percentage	24%	24%	19%	19%	9.5%	4.5%
p-value	0.34	0.34	0.39	0.39	0.68	0.55

**Tab. V.** General complications encountered according to TG type (2)

TG PROCEDURE	AF	HEMODYNAMIC INSTABILITY	RESPIRATORY ARREST	CARDIOPULMONARY ARREST
Roux-en-Y	-	-	1	3
Omega TG	2	2	-	1
Total	2	2	1	4
Percentage	3.1%	3.1%	1.6%	6.3%
p-value	0.0004	0.0004	0.68	0.52

cally significant correlations were observed between specific complications and the type of TG.

Reoperation was necessary in seven patients, with a reoperation rate of 9.1%. The most frequent indication for reoperation was esophagojejunal fistula (n=4, 57.1%), followed by peritonitis (n=2, 28.6%) and subphrenic abscess (n= 1, 14.3%). Of the patients who required reoperation, 5 (71.4%) underwent Roux-en-Y esophagojejunostomy (OR: 0.36, 95% CI: 0.09-2.19, p=0.27). Eight patients died during the hospital stay, yielding a mortality rate of 10.4%. A total of 6 (9.1%) deaths (5 per 66) were reported in patients who underwent Roux-en-Y esophagojejunostomy, while 2 (18.1%) patients died after Omega-Braun TG (2 per 11). Postoperative parameters are further presented in Table 7.

Postoperative parameters including length of stay (LOS), number of postoperative days and resumption of oral alimentation were comparable among the two procedures. The mean LOS was 18 days in both groups, however, the range was longer following Roux-en-Y: 11-60 days compared to 12-25 following Omega-Braun TG. The mean number of postoperative stay in both groups was 13 days. Patients resumed oral alimentation one day earlier in the Omega-Braun group: day 7 compared to day 8 following Roux-en-Y.

## DISCUSSION

A complication rate of 47.5% was documented in this study. The most common complication encountered in this study was secondary anemia due to abundant intraoperative bleeding, which occurred in 20 (31.7%) patients. The complication rate obtained in our study is higher than that recorded in the literature, which varies between 9% and 46% [4,5]. Selby et al. conducted a 90-day

**Tab. IV.** General complications encountered according to TG type (1)

TG PROCEDURE	SECONDARY ANEMIA	FEVER	PERICARDITIS	PERICARDIAL EFFUSION	MSOF
Roux-en-Y	18	11	1	1	2
Omega TG	2	3	-	-	1
Total	20	14	1	1	3
Percentage	31.7%	22.2%	1.6%	1.6%	4.7%
p-value	0.52	0.39	0.68	0.68	0.33

**Tab. VI.** Respiratory complications encountered according to TG type

TG PROCEDURE	PLEURAL EFFUSION	BRONCHOPNEUMONIA	ATELECTASIS	TRACHEAL ASPIRATION
Roux-en-Y	5	4	3	1
Omega TG	1	-	-	-
Total	6	4	3	4
Percentage	9.5%	6.3%	4.8%	1.6%
p-value	0.86	0.40	0.47	0.68

analysis of outcomes in 238 patients after TG. At least one adverse postoperative event occurred in 62% of patients; a considerably higher figure than our rate of 47.5%. The most common postoperative complication documented in Shelby et al.'s study was also secondary anemia, which is consistent with the findings in our study [5].

Esophageal anastomotic leak is one of the most detrimental and potentially fatal postoperative complications occurring after upper gastrointestinal surgery. The rate of anastomotic leakage following TG for gastric carcinoma is as high as 26%, with an average rate of 5-8% [7-9]. The rate of leakage observed in our study (19%, n=4) is not only consistent with the literature, but also matches the rate observed in an analysis of 1,114 TG procedures performed over a 30-year period at the Hannover Center for Visceral Surgery and conducted by Lang et al. [10].

We recorded a reoperation rate of 9.1% and a mortality rate of 10.4%. The mortality rate documented in our study falls within the reported range described in the literature (1.1%-10.8%) [4,5]. The most frequent indication for reoperation in our study was esophagojejunal fistula, which occurred in 4 of the 9 patients who required reoperation after the Roux-en-Y procedure, yielding a rate of 6.1%. Our rate was higher than the rate of 4.8% reported by Milek et al. in a study of 487 Roux-en-Y TG procedures that were carried out over an 18-year period [11].

The main advantage of Roux-en-Y esophagojejunostomy observed in this study was a lower mortality rate: 5 (7.6%) deaths (5 per 66 operations) compared to 2 (18.1%) deaths (2 per 11 operations) after Omega-Braun TG. The latter was characterized by a higher proportion of local complications compared to general complications, and required a shorter operative

time. A disadvantage of Roux-en-Y esophagojejunostomy was a higher reoperation rate (22.2%). Although there are a number of surgical techniques available for performing TG, Roux-en-Y esophagojejunostomy is considered the golden standard procedure [8,9,12].

The most prominent limitation of this study is the evident surgeon's bias towards the performed procedure. Omega-Braun TG was performed by only 11 surgeons, while 66 surgeons opted for Roux-en-Y esophagojejunostomy. There was no criterion to choose one method over the other, it was simply the surgeon's preference. Due to the considerably unequal distribution among the two surgical techniques, outcomes could not be objectively evaluated. A proposed reason for this bias may be the greater technical complexity and longer operative time required for Omega-Braun TG. A similar surgeon's bias was noticed by Budisin et al. in a study of 76 patients who underwent TG for gastric cancer; only 5.3% of surgeons chose Omega-Braun TG compared to 53.9% of surgeons who selected Roux-en-Y esophagojejunostomy [13]. Other limitations include a retrospective nature of the study and a modest patient number. Furthermore, the lack of laparoscopic operations made it impossible to compare outcomes of laparotomy and laparoscopy. Lastly, no D3 lymphadenectomies were attempted.

Laparoscopic TG is a technically difficult procedure, not only due to an extensive lymphadenectomy but also due to the complex task of creating a permeable, yet leak-free esophagojejunal anastomosis. In order to combat this dilemma, Smolarek et al. decided to employ an OrVil device as an alternative to the standard linear stapler. The authors obtained a favorable outcome in their patient. However, large scale studies are urgently needed in order to evaluate its long-term applicability [14].

There is a need for a larger scale prospective study evaluating postoperative outcomes in real-time, with an equal distribution among the two surgical procedures, in addition to laparoscopic operations.

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Tab. VII. Postoperative parameters

CHARACTERISTIC	ROUX-EN-Y (N=66)	OMEGA-BRAUN (N=11)	ODDS RATIO (OR)	95% CI	P-VALUE
Number of Patients with Complications					
Present	32 (48.5%)	3 (27.3%)	0.39	0.09-1.63	0.20
Absent	34 (5.5%)	8 (72.7%)			
Complications as per number (Total: 84)	72	12	-	-	-
Mortality					
Yes	6 (9.1%)	2 (18.2%)	0.37	0.07-2.58	0.37
No	60 (90.9%)	9 (81.8%)			
Reoperation					
Yes	5 (7.6%)	2 (22.2%)	0.36	0.06-2.19	0.27
No	61 (92.4%)	9 (77.8%)			

## CONCLUSION

Total gastrectomy, despite its association with significant postoperative complications, is the procedure of choice for curative resection of gastric carcinoma. We reported an overall postoperative complication rate of 45.7% with a reoperation rate of 9.1% and a mortality rate of 10.4%. To conclude, this study deemed Roux-en-Y Esophagojejunostomy the safer procedure.

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Word count: 2700      Page count: 6      Tables: 7      Figures: –      References: 14

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DOI: 110.5604/01.3001.0010.1048

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Competing interests: The authors declare that they have no competing interests.

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Cite this article as: McKenzie Stancu S., Popescu B.; Comparative Analysis of Immediate Postoperative Complications Following Total Gastrectomy; Pol Przegl Chir 2017; 89 (32):1-6

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