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ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

Impact of reconstructive procedures with and without preserving the duodenal passage on body weight in patients after total gastrectomy for gastric cancer

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SUMMARY

Introduction/Objective The ideal reconstruction procedure after total gastrectomy should replace all lost functions of the stomach.
The aim of this study was to evaluate the usefulness of preserving the duodenal passage in subsequent improvement of body weight (BW) and body mass index (BMI) in patients with gastric cancer after total gastrectomy.

Methods A total of 30 patients with gastric cancer were prospectively randomly divided into a group of reconstruction with double-tract (n = 15) and a group of reconstruction with simple Roux-en-Y after total gastrectomy. They were stratified by sex, age, their anthropometric measurements (BW, BMI), primary tumor localization, Lauren's classification, TNM stage classification, length of hospital stay, operation duration, postoperative complications, and mortality. Postoperatively, BW and BMI were measured at three, six, and 12 months and compared between the two groups.

Results The clinical group of double-tract patients had significantly higher the values of BW in the postoperative period after six (66.6 ± 4.9 vs. 61.7 ± 7.6; $p < 0.05$ paired Student's t-test) and after 12 months (67.0 ± 4.9 vs. 62.3 ± 7.2; $p < 0.05$ paired Student's t-test) compared to the group of Roux-en-Y patients. On the other hand, the clinical group of double-tract patients also had significantly higher the values of BMI in postoperative period after 12 months (23.6 ± 1.1 vs. 22.5 ± 1.6; $p < 0.05$ paired Student's t-test) in relation to the Roux-en-Y group of patients.

Conclusion Reconstruction procedure carried out after total gastrectomy which implies preserving the duodenal passage has significant increase of BW and BMI, compared to reconstruction procedure without the preservation of the duodenal passage.

Keywords: reconstructive procedure; body weight; body mass index

INTRODUCTION

Gastric cancer (GC) represents one of the most frequent neoplasia worldwide, and specifically the fourth and fifth most common cancer in men and women and the third and fifth cause of cancer-related death [1].

The first successful total gastrectomy (TG) was performed by Schlatter in 1897 [2]. Until the middle of the 20th century, surgeons had been primarily concerned with preventing severe surgical complications of gastrectomy [3]. TG results in risk of postgastrectomy syndrome, such as weight loss, dumping syndrome, reflux esophagitis, gall stones, and a reduction in the quality of life [3, 4]. The ideal reconstruction procedure (RP) after TG should replace all lost functions of the stomach [4]. Many RPs have been described in literature. All RPs can be subdivided into those excluding the duodenal passage with or without pouch construction, and others preserving the duodenal passage with or without pouch construction [2].

The aim of this study was to evaluate the usefulness of preserving the duodenal passage in subsequent improvement of body weight (BW) and body mass index (BMI) in patients with GC after TG.

METHODS

Patients

In this prospective study a total of 30 patients with primary GC surgically treated at the Department of Gastrointestinal Surgery of the Clinical Center of Niš. Fifteen patients with GC treated by TG and reconstruction with simple Roux-en-Y (RY) and fifteen patients treated with TG and reconstruction with double-tract (DT) from 2004 to 2011 were investigated in the current study.

Criteria based on the group of patients with created RY DT configuration reconstruction, after total gastrectomy, were the following:

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1) patients in stage II GC according to TNM classification, and 2) patients with better nutrition status and greater level of successful post-surgery survival rate.

Clinicopathologic investigation

Histological confirmation of neoplasia was preoperatively achieved by endoscopic biopsies. Patients under the cachectic condition due to the recurrence of the tumor or with BW gain with ascites from peritoneal metastasis were excluded from the study. TG was performed according to tumor location and the possibility to obtain negative resection margins and a potentially curative (R0) resection. Tumor stage was defined according to the pathological tumor node metastasis (TMN) classification proposed by the International Union Against Cancer. All cases before 2010 were revised as the TNM classification has been updated in its seventh edition [5].

Description of the reconstructive procedure after TG

The surgical procedures for the DT and RY reconstruction techniques following TG are shown in figures [6]: standard RY reconstruction without preserving the duodenal passage, and reconstruction with the preservation of the duodenal passage by creating a RY DT configuration (Figure 1); intraoperative presentation reconstruction with the preservation of the duodenal passage by creating a RY DT with create esophagojejunal end-to-end and jejunoduodenal side-to-end anastomosis (Figure 2).

Follow-up of the patients

Clinical characteristics, surgical procedures, and histological findings were recorded in a specific database. We compared the two groups (DT, RY) regarding their anthropometric measurements, primary tumor localization, Lauren classification, TNM stage classification, length of hospital stay, duration operation, postoperative complications, and mortality. The patients were followed up according to the following protocol: each patient's height and BW was measured preoperatively and postoperatively three, six, and 12 months after surgery. BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m^2).

Statistical analysis

Quantitative statistical analysis, writing, ranking, clustering, tabular, and graphical presentation of data was performed using Microsoft Office Excel 2013. Calculations were performed by using R version 2.12.0 (R Foundation for Statistical Computing, Vienna, Austria). The data are presented as the mean ± standard deviation. Comparison of the numerical characteristics between the RY and DT patients were determined using Student's t-test. Statistical comparison of specific attributes of characteristics in both groups of patients (DT, RY) were determined by the χ^2 test or Fisher's exact probability test. When the frequency of examined characteristics is $p < 0.05$, it could be considered statistically significant.

RESULTS

This prospective study analyzed 30 patients with GC after TG. Regarding RP, 15 patients had received reconstruction by the DT method, and 15 had received reconstruction by the RY method.

The clinicopathological features of both groups of patients (DT, RY) are summarized in Table 1.

In the clinical group of RY patients there were 10 men (66.6%) and five women (33.3%). In the clinical group of DT patients were 11 men (73.3%) and four women (26.7%). Among the studied clinical groups of patients there was no statistical significance ($p = 0.690$) according to sex.

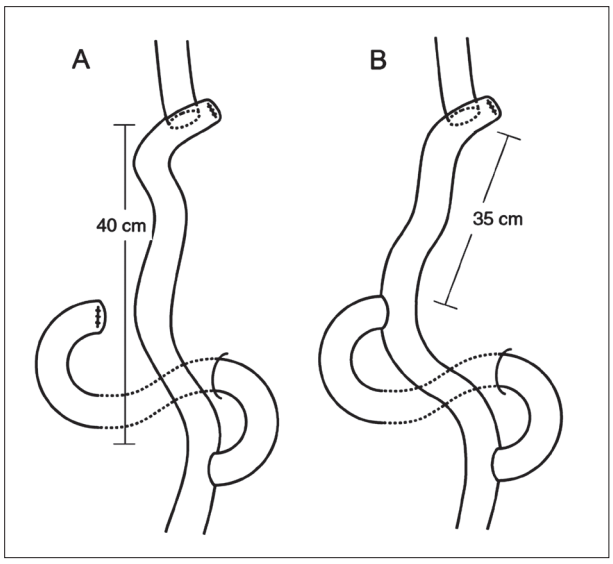

Figure 1. Surgical procedures for the double tract and Roux-en-Y reconstruction techniques following TG: A) standard Roux-en-Y reconstruction without preserving the duodenal passage; B) reconstruction with preserving the duodenal passage by creating a Roux-en-Y double tract configuration

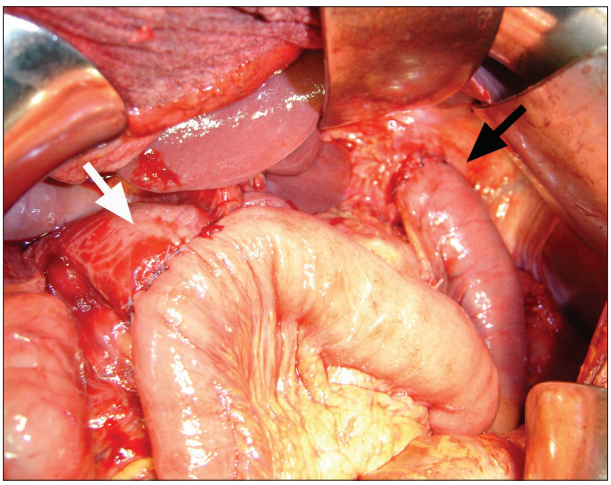

Figure 2. Intraoperative presentation reconstruction with preserving the duodenal passage by creating a Roux-en-Y double tract by creating esophagojejunal end-to-end (black arrow) and duodenojejunal end-to-side anastomosis (white arrow)

Table 1. Clinicopathological features of both patient groups (DT, RY)

Patient characteristics		RY group (n = 15)	DT group (n = 15)	p-value
Sex	Male	10 (66.7%)	11 (73.3%)	0.690
	Female	5 (33.3%)	4 (26.7%)	
Lauren's classification	Diffuse	13 (86.7%)	13 (86.7%)	0.999
	Intestinal	2 (13.3%)	2 (13.3%)	
Primary tumor localization	Upper third	7 (46.7%)	5 (33.3%)	0.693
	Middle third	7 (46.7%)	8 (53.3%)	
	Lower third	1 (6.7%)	2 (13.3%)	
TNM stage classification	II	6 (40.0%)	8 (53.3%)	0.464
	III	9 (60.0%)	7 (46.7%)	
Duration of operation (minutes)		179.60 ± 10.15	178.13 ± 11.87	0.719
Length of hospital stay (days)		13.07 ± 0.88	13.20 ± 1.26	0.740
Mortality		0 (0.0%)	0 (0.0%)	0.999

The values are given as number (%) of patients, and as mean ± standard deviation;

RY – reconstruction procedure with simple Roux-en-Y; DT – double-tract reconstruction procedure

The mean age was 60.6 ± 13.1 years in the DT group, and 65.3 ± 6.5 years in the RY group. There were no significant differences (p = 0.464) between the two patient groups according to age.

The patients represented tumor stages II and III. Of the 15 RY patients, six (40%) had had stage II, and nine (60%) stage III tumor, according to the TNM classification. Of the 15 DT patients, eight (53.3%) had had stage II, and seven (46.6%) stage III tumor, according to the TNM classification. There were no significant differences (p = 0.464) between the two patient groups according to the TNM classification.

According to Lauren's classification, of the 15 RY patients, 13 (86.7%) had had diffuse form, and two (13.3%) infiltrative form. Of the 15 DT patients, 13 (86.7%) had had diffuse form, and two (13.3%) infiltrative form, according to Lauren's classification. There were no significant differences (p = 0.999) between the two patient groups according to the Lauren's classification.

According to the primary tumor localization, of the 15 RY patients, seven (46.7%) had had upper third, seven (46.7%) middle third, and one (6.7%) lower third. Of the 15 DT patients, five (33.3%) had had upper third, eight (53.3%) middle third, and two (13.3%) lower third. There were no significant differences (p = 0.693) between the two patient groups according to the primary tumor localization.

None of the patients died during the postoperative hospital stay.

The mean length of hospital stay for the RY group was not significantly shorter than that for the DT group (13.07 days vs. 13.2 days). These differences did not reach statistical significance (p = 0.740).

Duration of operation for the RY group was not significantly shorter than that for the DT group (178.13 minutes vs. 179.6 minutes). These differences did not reach statistical significance (p = 0.719).

Table 2. Distribution of clinical groups of patients according to postoperative complications as compared to the type of reconstructive procedure

Postoperative complications	Number of patients (%)		p-value
	RY group (n = 15)	DT group (n = 15)	
Anastomotic leakage	0 (0.0)	0 (0.0)	0.999
Left subphrenic abscess	0 (0.0)	0 (0.0)	0.999
Gastric motility disorders	0 (0.0)	0 (0.0)	0.999
Anastomotic block	0 (0.0)	0 (0.0)	0.999
Intra-abdominal abscesses	0 (0.0)	0 (0.0)	0.999
Intra-abdominal bleeding	0 (0.0)	0 (0.0)	0.999
Wound infections	0 (0.0)	1 (6.7)	0.690
Pancreatitis acuta	1 (6.7)	0 (0.0)	0.690
Arrhythmia	1 (6.7)	1 (6.7)	0.999
Pneumonia	1 (6.7)	0 (0.0)	0.690
Angina pectoris	1 (6.7)	0 (0.0)	0.690

Postoperative complications (anastomotic leakage, gastric motility disorders, anastomotic block, intra-abdominal abscesses, intra-abdominal bleeding) in both (DT, RY) groups were not found. There were no significant differences (p = 0.999) between the two patient groups according to postoperative complications in the postoperative period, as presented in Table 2.

Postoperative complications (pancreatitis acuta, wound infections, arrhythmia, angina pectoris, pneumonia) were found in both (DT, RY) groups. There were no significant differences (p = 0.690) in the values between the two patient groups according to postoperative complications in the postoperative period.

Student's t-test confirmed that the DT group had significantly higher values of BW in the postoperative period after six (66.6 ± 4.9 vs. 61.7 ± 7.6; p < 0.05) and 12 months (67.0 ± 4.9 vs. 62.3 ± 7.2; p < 0.05), in relation to the RY group, as presented in Table 3.

Student's t-test confirmed that DT group had significantly higher values of BMI in the postoperative period

Table 3. Distribution of clinical patient groups according to body weight as compared to the type of reconstructive procedures

Body weight (kg)	Mean value ± SD		p-value
	RY group (n = 15)	DT group (n = 15)	
Preoperative	68.3 ± 9.5	68.1 ± 4.9	0.924
After 3 months	62.0 ± 7.5	64.0 ± 4.9	0.389
After 6 months	61.7 ± 7.6	66.6 ± 4.9	0.044*
After 12 months	62.3 ± 7.2	67.0 ± 4.9	0.046*

*p-values (paired-samples t-test) – statistically significant difference

Table 4. Distribution of clinical patient groups according to body mass index (BMI) as compared to the type of reconstructive procedures

BMI (kg/m^2)	Mean value ± SD		p-value
	RY group (n = 15)	DT group (n = 15)	
Preoperative	23.0 ± 2.1	22.9 ± 1.2	0.902
After 3 months	22.2 ± 1.7	22.6 ± 1.1	0.958
After 6 months	22.3 ± 1.6	22.9 ± 1.1	0.306
After 12 months	22.5 ± 1.6	23.6 ± 1.1	0.047*

*p-values (paired-samples t-test) – statistically significant difference

after 12 months (23.6 ± 1.1 vs. 22.5 ± 1.6; $p < 0.05$), in relation to the RY group, as presented in Table 4.

DISCUSSION

TG is widely used as a major surgical treatment for GC [7]. The choice of RP should ensure good digestive function to prevent persistent postgastrectomy syndrome [2]. The first discussion of DT RM use was made by Kajitani and Sato in 1965 [6]. DT procedure certainly has a number of benefits, from better passage of food through the duodenum, mixing of food with pancreatic juices and bile acids, to a much better endoscopic accessibility to the ampulla of Vater (papilla Vateri), and the absence of risk of postoperative stamp rupture [8].

After GT, the first application of RY anastomosis was performed by Orr [6]. The disadvantages of RY include a different route of reconstruction in which all food passes through the jejunum, bypassing the duodenum, the possibility of Roux stasis syndrome, an increased probability of cholelithiasis, increased difficulty with an endoscopic approach to the papilla of Vater [8]. When it comes to diet, nutritional status, and the quality of life, this procedure certainly is not up to the required level [6]. DT is superior to RY in preventing malnutrition and patients gain more BW. A possible explanation for these findings is reduced food intake as a result of loss of reservoir function, but they also occur as a result of disturbance of the natural process of digestion by the loss of secretory function [2].

The passage of food triggers the secretion of intestinal hormones, such as secretin, cholecystokinin, and insulin. Based on this, the preservation of the duodenal passage has shown positive effects on regulating blood sugar level after TG [9].

The ideal RP should provide a large enough reservoir that can accommodate to the size of the meal, prevent reflux and dumping, ensure strong propulsion of equal-sized boluses of chyme entering the duodenum, and respond properly to the changing levels of gastrointestinal hormones and neural information. Gastrointestinal hormone studies demanded the superiority of duodenum-preserving resection [4].

Many authors have shown that RPs which allow some duodenal passage have many favorable effects especially in digestion and absorption of lipids [10].

TG is often accompanied by a postoperative BW gain and initiating poor nutritional status [7]. It is well known that a patient's nutritional status correlates with morbidity and mortality. Malnutrition usually manifests as BW loss, and many authors have reported a loss after TG of 15–24% of preoperative BW. Relative pancreatic insufficiency could result in malabsorption in patients whose reconstruction excluded the duodenal passage of food [11]. Clinicians tend to consider BW as a measure of nutritional status. A decrease of gastric acid level, intestinal floral alteration, increased peristalsis and diarrhea, reduced food intake, and limited reservoir function are the most conceivable explanations for BW loss after TG [12].

Preservation of duodenal transit with replacement of the jejunal segment, the so-called physiological route, is now believed to be preferential for postoperative nutritional condition [13]. The interposition of the jejunum between the esophagus and duodenum provides advantages in terms of nutritional benefits by secreting hormones through the duodenal passage and endoscopic accessibility to the duodenum, biliary tract, and pancreas. Recently, postoperative advantages of DT after TG have been reported, in terms of patients' BW, quality of life, and nutritional conditions [14]. Takase et al. [10] concluded that fat absorption influenced nutrition in BW recovery of patients after gastrectomy.

Main indications for DT and jejunal interposition reconstruction, as well as methods that ensure the passage of food and physiological recovery, are patients with GC in an early stage and young patients with TG and expected long-term survival [13]. Iwahashi et al. [6] reported that food intake significantly decreased soon after the operation. It was only 64.5% in the RY group and 67.5% in the DT group at three months. Thereafter, it gradually recovered during the course of the postoperative period. BW was also significantly decreased throughout the following period ($p = 0.05$), and it also gradually recovered. However, the percentage of BW was only 70% in the RY group and 77.8% in the DT group one year after the operation.

Another research found that BW gain was better in the group with preserved duodenal passage compared to the group without it in periods of 12 and 24 months after the operation [2]. Also, patients treated by TG and esophagojejunostomy with RY occasionally have dysphagia and appetite loss that result in BW loss [14]. Kalmár et al. [15] reported that TG leads to significant BW loss in 40–90% of patients. Kalmár et al. [16] reported that RY patients suffered from postgastrectomy syndrome throughout the follow-up period. In reconstructions where the duodenal passage cannot be preserved, a pancreaticocibal asynchronism occurs, i.e secretion of gastrointestinal hormones in a sequence which results in a disturbance of optimal gastrointestinal motility and digestion. Kiyama et al. [17] have also confirmed that BW loss is a very common problem after TG and it generally occurs during the first three months after surgery. Patients who underwent an RY RP had the lowest nutrition risk index, and their BW decreased significantly. Additionally, relatively high frequency of gallstones after gastrectomy is well known. Preserving the duodenal passage is advantageous for patients with gallstones by allowing interventional treatment even in cases of cholangiopancreatic malignancy [18]. Ryu et al. [19] found that BW and BMI were significantly reduced six and 12 months after surgery [15]. Khomichuk et al. [20] found that mean body fat mass significantly decreased in men (7.4 ± 5 kg) and women (12 ± 7.1 kg) in comparison to normal values (18.2 and 22.5) ($p < 0.001$). The nutritional status of patients who had undergone TG showed a significantly reduced nutritional status in terms of BW, BMI in the period 12 months after the operation. In our study, BW i BMI were decreased three and six months after the operation in both groups of patients. Patients with RY showed a significantly

reduced nutritional status in terms of BW, BMI as compared to DT patients. After 12 months, BW of the DT group is typically normalized to the pre-operative values, which is not the case with the RY group, which exhibited substantial BW loss. Also, after 12 months, BMI of the DT group is typically normalized to the pre-operative BW, in contrast to the RY group, which showed mass loss. Hoksch et al. [21] and Zherlov et al. [22] have shown that patients with preserved duodenal passage lose less BW and BMI, and have fewer symptoms as a result of RM. Tyrväinen et al. [23] reported that the majority of patients after TG has consequences in terms of malnutrition and BW loss. Loss of BW, which is between five and 10 kg, or 2 units of BMI are carried out in the first three months after the operation. Another research reported that most of patients with TG had experienced rapid BW loss soon after the surgical treatment. The BW decreases within six months after surgery. After this period, the patient with Longmire reconstruction recovered significantly better than patients with RY [21]. Also, patients with the passage of food through the duodenum had significantly better survival rates than those without it in 1A, 1B, 2, and 3A GC stages [24].

CONCLUSION

Based on the obtained results, it can be concluded that patients who underwent an RP with the preservation of the duodenal passage have a significant increase of BW and BMI compared to RPs without the preservation of the duodenal passage. RPs which allow duodenal passage should be regarded as a key to physiological reconstruction.

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Утицај реконструктивних процедура са презервацијом дуоденалне пасаже и без ње на телесну масу код болесника после тоталне гастректомије због карцинома желуца

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САЖЕТАК

Увод/Циљ Идеална реконструктивна процедура (РП) након тоталне гастректомије (ТГ) треба да надомести све изгубљене функције желуца.

Циљ ове студије је да процени корисност презервације дуоденалне пасаже (ПДП) са последичним побољшањем телесне тежине (ТТ) и индекса масе тела (ИМТ) код пацијената са карциномом желуца након ТГ.

Методе Тридесет пацијената са карциномом желуца су проспективно подељени у групу са *double tract* реконструкцијом (ДТ) (б = 15) и групу са применом *Roux-en-Y* (б = 15), а након изведене ТГ. Пацијенти су упоређивани на основу пола, година, ТТ, ИМТ, примарне туморске локализације, Лауренове класификације, ТНМ класификације, дужине хоспитализације, трајања операције, постоперативних компликација, морталитета. Постоперативно, ТТ и ИМТ су мерени након три, шест и 12 месеци и упоређивани између две групе на основу типа реконструкције.

Резултати Клиничка група пацијената са ПДП је имала сигнификантне више вредности ТТ у постоперативном периоду након шест (66,6 ± 4,9 према 61,7 ± 7,6; $p < 0,05$ т-тест за везане узорке) и након 12 месеци (67,0 ± 4,9 према 62,3 ± 7,1; $p < 0,05$ т-тест за везане узорке), у поређењу са клиничком групом пацијената без ПДП. Такође, клиничка група пацијената са ПДП је имала сигнификантно више вредности ИМТ у постоперативном периоду након 12 месеци (23,6 ± 1,1 према 22,5 ± 1,6; $p < 0,05$ т-тест за везане узорке) у поређењу са другом групом пацијената без ПДП.

Закључак РП изведене након ТГ које ПДП имају сигнификантно повећање ТТ и ИМТ у поређењу са РП без ПДП.

Кључне речи: реконструктивне процедуре; телесна тежина; индекс масе тела