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Evaluation of Quality of Life in Gastric Cancer Patients Undergoing Different Surgical Reconstruction Methods.
A Comparative Study using the EORTC QLQ-STO22 Questionnaire

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Abbreviations:
HRQoL: Health-related quality of life;
QoL: Quality of life;
EORTC: European Organisation for Research and Treatment of Cancer;
QLQ: Quality of Life Questionnaire;
QLQ-STO22: EORTC gastric cancer - specific module;
RY: Roux-en-Y;
SD: Standard deviation;
IQR: Interquartile range.

Rezumat

Evaluarea calității vieții la pacienții cu cancer gastric supuși diferitelor metode de reconstrucție chirurgicală: studiu comparativ utilizând chestionarul EORTC QLQ-STO22

Introducere: Cancerul gastric rămâne o problemă majoră de sănătate la nivel global. Dincolo de rezultatele oncologice, calitatea vieții legată de sănătate (HRQoL) este tot mai des considerată ca un indicator esențial, influențat de metodele de reconstrucție digestivă în cadrul neoplasmului gastric.
Materiale şi Metodă: Am efectuat un studiu observațional prospectiv între octombrie 2021 şi decembrie 2024 la Spitalul Clinic Județean de Urgență Târgu Mureş, România, incluzând 150 de pacienți tratați chirurgical pentru neoplasm gastric. Pacienții au fost împărțiți în două grupuri: anastomoză gastroduodenală (Billroth I, n=72) şi anastomoză gastrojejunală (Billroth II/ Roux-en-Y, n=78). HRQoL a fost evaluată prin chestionarul EORTC QLQ-STO22 preoperator şi la 3 şi 6 luni postoperator. Scorurile au fost transformate liniar pe o scală 0-100. Analiza statistică a fost efectuată cu EasyMedStat.
Rezultate: Vârsta medie a fost de 61 de ani, fără diferențe semnificative între grupuri. Complicațiile postoperatorii au apărut la 32,0% dintre pacienți, în principal gradele I-II. Ambele grupuri au prezentat o deteriorare a disfagiei, durerii, refluxului şi anxietății la 3 luni, urmată de o recuperare parțială la 6 luni. Scorurile de reflux au fost constant mai mari în grupul cu reconstrucție gastrojejunală la toate momentele de evaluare. Restricțiile alimentare au fost, de asemenea, mai accentuate la 3 şi 6 luni.
Concluzii: Ambele metode de reconstrucție afectează HRQoL pe termen scurt, cu recuperare parțială la 6 luni. Anastomoza gastrojejunală se asociază cu reflux şi restricții alimentare mai mari, în timp ce anastomoza gastroduodenală are rezultate funcționale mai favorabile.

Cuvinte cheie: cancer gastric, gastrectomie, calitatea vieții, EORTC QLQ-STO22, Billroth I, Billroth II, reconstrucție

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Abstract

Background: Gastric cancer remains a major global health burden. Beyond oncologic outcomes, health-related quality of life (HRQoL) is increasingly recognized as a critical endpoint influenced by the reconstruction method after gastrectomy.

Methods: A prospective observational study was conducted between December 2021 and December 2024 at the Emergency County Hospital of Târgu Mureş, Romania, including 150 patients undergoing curative-intent gastrectomy. Patients were divided into two groups: gastroduodenal anastomosis (Billroth I, n=72) and gastrojejunal anastomosis (Billroth II/Roux-en-Y, n = 78). HRQoL was assessed using the EORTC QLQ-STO22 preoperatively and at 3 and 6 months postoperatively. Scores were linearly transformed to a 0–100 scale. Statistical analysis was performed with EasyMedStat

Results: The mean age was 61 years, with similar baseline characteristics. Postoperative complications occurred in 32.0% of patients, mostly grade I–II. Both groups showed deterioration in dysphagia, pain, reflux, and anxiety at 3 months, followed by partial recovery at 6 months. Reflux scores were consistently higher in the gastrojejunal group at all timepoints (baseline 26.1 vs. 17.6; 3 months 36.5 vs. 24.5; 6 months 27.2 vs. 14.7; $p < 0.001$). Eating restrictions were also greater at 3 and 6 months.

Conclusions: Both reconstruction methods impair short-term HRQoL, with partial recovery by 6 months. Gastrojejunal reconstruction is associated with higher reflux and eating restrictions, whereas gastroduodenal reconstruction shows more favorable functional outcomes

Keywords: gastric cancer, gastrectomy, quality of life, EORTC QLQ-STO22, Billroth I, Billroth II, Roux-en-Y, reconstruction

Introduction

The Global Burden of Disease Study 2021 shows gastric cancer continues to be a significant global health problem even though detection and treatment methods have improved (1). Projections indicate that case numbers will persist at current levels until 2035 unless preventive measures become more intense (2). The geographic distribution of incidence and mortality rates shows great variations between regions because of different elements, including risk factors and healthcare systems, and social status (3). The known risk factors for gastric cancer include Helicobacter pylori infection and smoking, together with high-salt diets and certain premalignant conditions (4).

Surgical resection stands as the only effective treatment that cures localized gastric cancer (5). The modern oncologic outcomes need to achieve a balance with functional recovery as well as long-term quality of life (QoL) (6). The oncologically sound total gastrectomy provides adequate clearance in particular situations, yet leads to major nutritional complications and functional issues, which drives surgeons to select function-preserving resections when possible (7,8). Reconstruction techniques alongside proximal and distal gastrectomies work to reduce the degree of postoperative dysfunction (9). Laparoscopic and laparoscopy-assisted surgical procedures demonstrate their safety and effectiveness through randomized clinical trials when compared to traditional open surgery (10), yet elderly and frail patients face elevated risks during the perioperative period (11).

Nutritional adequacy, along with gastrointestinal symptoms and physical function, determines postoperative QoL, thus necessitating an equilibrium between oncological success and digestive continuity preservation (15). The EORTC QLQ-STO22 stands as a leading gastric cancer-specific assessment tool that measures patient-reported outcomes through its contemporary treatment modalities and multicultural validation (16,17). The EORTC QLQ-STO22 functions with the EORTC QLQ-C30 to evaluate symptom clusters that include dysphagia and reflux, pain, and eating restrictions together with psychosocial dimensions (18–20) for both large surgical studies (19,20) and broad oncologic fields (21,22). Studies have proven the psychometric validity of this tool when used with patients undergoing gastrectomy (23-25).

The most common reconstruction procedures for distal gastrectomy patients involve either gastroduodenal anastomosis (Billroth I) or gastrojejunal anastomosis (Billroth II or Roux-en-Y) (26-27). The restoration of alimentary continuity through Billroth I is most natural, yet its applica-

bility depends on tumor position and anastomotic tension (26,27). The choice of Billroth II or Roux-en-Y is preferred for situations where direct duodenal anastomosis is not possible because it minimizes duodenogastric reflux yet leads to alterations in nutrient absorption (28,29). Current network analysis, together with meta-analysis, has improved the understanding of symptom management along with nutritional results and enduring quality of life (28-30). The uncut Roux-en-Y represents a reconstruction variation that reduces bile reflux without compromising motor function (30). The method of performing anastomosis between hand-sewing and stapling can impact the short-term healing process (31).

Extensive research has not established a clear agreement regarding the best reconstruction technique to achieve the best possible quality of life after gastrectomy (32). The decision for surgery depends on three main factors, which include tumor position, stage, and patient comorbidities, along with surgeon experience (33). Advanced disease patients can undergo validated total gastrectomy with D2 lymphadenectomy (34) while subtotal gastrectomy serves as a standard procedure for selected patients to maintain functional ability without compromising cancer treatment success (35).

The research evaluates the EORTC QLQ-STO22 questionnaire to compare quality of life outcomes in gastric cancer patients who undergo gastroduodenal versus gastrojejunal anastomosis after resections for gastric cancer. The study aims to help surgeons make decisions by combining both oncological and patient-focused functional results.

Material and Method

We conducted at Emergency County Hospital - Târgu Mureş in Romania, General Surgery I Clinic a prospective observational study from October 2021 through December 2024, to compare post-operative health-related quality of life (HRQoL) between patients who received gastroduodenal anastomosis (Billroth I) and those who received gastrojejunal anastomosis (Billroth II or Roux-en-Y) after curative-intent gastrectomy for gastric cancer. The study received approval from the Medical Ethics Committee for Clinical Research of Emergency County Hospital - Târgu Mureş through their decision number 30104/07.10.2021. All research procedures followed the principles of the Declaration of Helsinki. The researchers obtained written informed consent from all study participants before their admission to the study.

The study included adult patients (≥18 years) with histologically confirmed gastric carcinoma who underwent scheduled elective subtotal gastrectomy with curative intent. The study excluded patients who had metastatic disease at diagnosis, as well as those needing palliative resections, together with those who were severely cognitively impaired or had major psychiatric disorders affecting HRQoL assessment.

The preoperative assessment included a thorough clinical history and physical examination as well as staging investigations according to institutional protocols and baseline HRQoL assessment. The reconstruction method was decided intraoperatively based on: tumor location and length of required distal margin (aiming for ≥ 3-5 cm where feasible), anticipated anastomotic tension after gastric transection and duodenal mobilization, the feasibility of a tension-free gastroduodenostomy with adequate perfusion, and patient-related constraints (severe comorbidity, prior upper-abdominal surgery, friable duodenum). When these criteria were met, Billroth I was preferred for its physiologic continuity. If a tension-free duodenal anastomosis was not achievable or margins were jeopardized, gastrojejunostomy was performed (Billroth II or Roux-en-Y). In Billroth II, a Braun enteroenterostomy was added in selected cases to mitigate bile reflux; in Roux-en-Y, limb length was ≥40 cm to reduce duodenogastric reflux.. The Billroth I group obtained alimentary continuity by performing gastroduodenal anastomosis in either end-to-end or end-to-side fashion, whereas the Billroth II and Roux-en-Y group underwent gastrojejunal reconstruction. The Roux-en-Y reconstruction technique required at least 40 cm of Roux limb to minimize bile reflux, and Braun enteroenterostomy was added in selected Billroth II cases to prevent afferent loop syndrome. The surgeons with high experience in gastric cancer surgery performed all procedures while conducting D1+ or D2 lymphadenectomy according to international oncologic standards. Pathologic stage was assigned per AJCC 8th edition. We report the distribution of pT and pN categories and overall pStage by reconstruction group. Neoadjuvant chemotherapy (yes/no, regimen) was recorded and included in descriptive tables; sensitivity analyses adjusted for neoadjuvant use.

The European Organisation for Research and Treatment of Cancer (EORTC) QLQ-STO22 (approved ID: 94947) questionnaire evaluated

HRQoL at three assessment points: before surgery and 3 months, and 6 months after surgery. The administration and scoring of the EORTC QLQ-STO22 followed the EORTC Quality of Life Group manual and the European Institute of Oncology consensus recommendations, ensuring methodological concordance with the current European validation framework. The tool consists of 22 items that measure five symptom domains consisting of dysphagia, pain, reflux, eating restrictions, and anxiety, together with four single-item questions about dry mouth, altered taste, body image, and hair loss. Participants rated every question by using a four-point Likert scale beginning at 1 ("Not at all") and ending at 4 ("Very much"). According to EORTC guidelines, the scoring process involved calculating a raw score from the component items, then transforming it into a standardized 0-100 scale through the formula $S=(RS-1)$ /range ×100, where RS stands for the raw score and range indicates the minimum to maximum possible scores. Higher scores on the symptom burden and functional limitation scales indicate increased symptoms or limitations.

EasyMedStat (EasyMedStat, Paris, France) was used to perform all statistical procedures. The research team presented categorical data through frequencies and percentages, then evaluated between-group differences using the χ^2 or Fisher's exact test as needed. The Shapiro-Wilk test was used to determine data normality, and standard deviation (SD) was presented for normally distributed variables; the median with interquartile range (IQR) was used for skewed distributions. The independent samples t-test or the Mann-Whitney U test determined differences between HRQoL scores from the two reconstruction groups during each assessment period. The evaluation of HRQoL score changes over time in each group employed repeated measures ANOVA for normally distributed data, but the Friedman test with Bonferroni-adjusted post hoc analysis was used for non-parametric data. The two-tailed statistical tests maintained p-values at a significance threshold below 0.05.

Results

The research involved 150 patients, where 72 patients received Billroth I gastroduodenal anastomosis and 78 patients received either Billroth II or Roux-en-Y reconstruction. The average participant age in the study reached 61.5 ± 10.8 years. The Billroth I patients averaged 60.4 ± 10.6 years old, while the Billroth II/Roux-en-Y patients averaged 62.5 ± 11.0 years old. The total number of participants included 91 males (60.7%) and 59 females (39.3%), with 42 men and 30 women in the Billroth I group and 49 men and 29 women in the Billroth II/Roux-en-Y group. The study included 98 patients (65.3%) with distal tumors alongside 39 patients (26.0%) with gastric body tumors, and 13 patients (8.7%) with multifocal tumors. Among the Billroth I patients, 46 cases were distal while 19 were body, and 7 were multifocal. The Billroth II/ Roux-en-Y group had 52 distal and 20 body tumors with 6 multifocal cases. Among the total of 150 participants, 122 patients (81.3%) had comorbidities, while the remaining 28 patients (18.7%) did not have any conditions. The Billroth I group showed comorbidities in 58 patients, yet 14 patients were comorbidity-free, whereas the Billroth II/Roux-en-Y group showed 64 patients with comorbidities and 14 patients without comorbidities (*Table 1*).

The study found hypertension to be the most prevalent condition among its 67 patients (44.7%), with almost equal distribution between reconstruction groups since Billroth I included 32 cases (44.4%) and Billroth II/Roux-en-Y included 35 cases (44.9%). The patient population showed type 2 diabetes mellitus in 52 cases (34.7%), with Billroth I patients representing 24 cases (33.3%) and Billroth II/Roux-en-Y patients representing 28 cases (35.9%). The medical records indicated 21 patients (14.0%) had coronary artery disease, among which 13 cases (18.1%) belonged to the Billroth I group and 8 cases (10.3%) belonged to the Billroth II/Roux-en-Y group. The frequency of chronic obstructive pulmonary disease was lower than other conditions at 14 patients (9.3%), with 5 patients (6.9%) from the Billroth I reconstruction group and 9 patients (11.5%) from the Billroth II/Roux-en-Y reconstruction group. Multiple comorbidities existed in 32 patients (21.3%) who had two or more chronic conditions without significant distribution between groups (*Table 2*).

According to the Clavien–Dindo classification system, a total of 48 patients (32.0%) experienced complications, with 23 cases (31.9%) from the Billroth I group and 25 cases (32.1%) from the Billroth II/Roux-en-Y group. The treatment of minor complications that corresponded to grade I involved 18 patients (12.0%) who received conservative management for wound infections and pneumonia with fever and electrolyte imbalances. Seventeen patients developed grade II complications that required pharmacological treatment

Table 1. Baseline characteristics of the study population

Variable	Billroth I (n=72)	Billroth II/RY (n=78)	Total (n=150)	p-value
Age (years)	60.4 ± 10.6	62.5 ± 11.0	61.5 ± 10.8	0.230*
Sex, n (%)				0.693**
Male	42 (58.3%)	49 (62.8%)	91 (60.7%)	
Female	30 (41.7%)	29 (37.2%)	59 (39.3%)	
Tumor site, n (%)				0.891**
Distal	46 (63.9%)	52 (66.7%)	98 (65.3%)	
Body	19 (26.4%)	20 (25.6%)	39 (26.0%)	
Multifocal	7 (9.7%)	6 (7.7%)	13 (8.7%)	
Comorbidity, n (%)				0.980**
Yes	58 (80.6%)	64 (82.1%)	122 (81.3%)	
No	14 (19.4%)	14 (17.9%)	28 (18.7%)	
pT stage				0.910**
	T1: 12 (16.7)	T1: 11 (14.1)	T1: 23 (15.3)	
	T2: 24 (33.3)	T2: 27 (34.6)	T2: 51 (34.0)	
	T3: 27 (37.5)	T3: 28 (35.9)	T3: 55 (36.7)	
	T4: 9 (12.5)	T4: 12 (15.4)	T4: 21 (14.0)	
pN stage				0.740**
	N0: 20 (27.8)	N0: 18 (23.1)	N0: 38 (25.3)	
	N1: 22 (30.6)	N1: 25 (32.1)	N1: 47 (31.3)	
	N2: 21 (29.2)	N2: 22 (28.2)	N2: 43 (28.7)	
	N3: 9 (12.5)	N3: 13 (16.7)	N3: 22 (14.7)	
Neoadjuvant therapy				0.750**
	Yes: 24 (33.3)	Yes: 28 (35.9)	Yes: 52 (34.7)	
	No: 48 (66.7)	No: 50 (64.1)	No: 98 (65.3)	

*Mann–Whitney U; **χ^2

Table 2. Baseline comorbidities by reconstruction group

Comorbidity	Billroth I	Billroth II/RY (n=72)	Total (n=78)	p-value (n=150)
Any comorbidity, n (%)	58 (80.6%)	64 (82.1%)	122 (81.3%)	0.980*
Hypertension (HTN), n (%)	32 (44.4%)	35 (44.9%)	67 (44.7%)	1.000*
Diabetes mellitus type 2 (DM2), n (%)	24 (33.3%)	28 (35.9%)	52 (34.7%)	0.874*
Coronary artery disease (CAD), n (%)	13 (18.1%)	8 (10.3%)	21 (14.0%)	0.254*
Chronic obstructive pulmonary disease (COPD), n (%)	5 (6.9%)	9 (11.5%)	14 (9.3%)	0.493*
Multiple comorbidities (χ^2), n (%)	16 (22.2%)	16 (20.5%)	32 (21.3%)	0.955*
No comorbidity, n (%)	14 (19.4%)	14 (17.9%)	28 (18.7%)	—

*χ^2

through transfusions and antibiotics. Seven patients with intra-abdominal collections were treated with antibiotics only, and four patients received conservative treatment and parenteral nutrition for their anastomotic leaks. Seven patients (4.7%) underwent interventions without general anesthesia during Grade IIIa complications, mostly requiring endoscopic dilatation for anastomotic stricture or percutaneous drainage of abscesses. Grade IIIb complications needing reintervention with general anesthesia occurred in six patients (4.0%) for anastomotic leakage or postoperative hemorrhage, or afferent loop obstruction. No grade IV complications were documented because patients with life-threatening conditions did not require ICU management. The five patients who died during the 30-day postoperative period (grade V) represented 3.3% of the total patients, while two patients belonged to the Billroth I group and three patients belonged to the Billroth II/Roux-en-Y group (*Tabel 3*).

When stratified by Clavien–Dindo grade was applied, 102 patients (68.0%) had no complications, 18 patients (12.0%) had grade I complications, 17 patients (11.3%) had grade II complications, 7 patients (4.7%) had grade IIIa complications, and 6 patients (4.0%) had grade IIIb complications. In the Billroth I group, there were 49 patients with no complications, 9 with grade I, 9 with grade II, 2 with grade IIIa, and 3 with grade IIIb. In the Billroth II/Roux-en-Y group, there were 53 patients with no complications, 9 with grade I, 8 with grade II, 5 with grade IIIa, and 3 with grade IIIb. The mean length of hospital stay was 11.4 days in the

Table 3. Postoperative complications by Clavien–Dindo grade and type

Complication type	Billroth I (n=72)	Billroth II/RY (n=78)	Total (n=150)
Postoperative complications	23 (31.9%)	25 (32.1%)	48 (32.0%)
Grade I (minor)	9 (12.5%)	9 (11.5%)	18 (12.0%)
Wound infection (local care ± antibiotics)	4	3	7
Pneumonia/fever (conservative management)	3	4	7
Electrolyte imbalance (IV correction)	2	2	4
Grade II (pharmacological)	9 (12.5%)	8 (10.3%)	17 (11.3%)
Postoperative bleeding requiring transfusion	4	3	7
Intra-abdominal collection (antibiotics only)	3	3	6
Anastomotic leak (conservative/parenteral nutrition)	2	2	4
Grade IIIa (intervention w/o GA)	2 (2.8%)	5 (6.4%)	7 (4.7%)
Endoscopic dilatation (anastomotic stricture)	1	2	3
Percutaneous drainage (abscess/collection)	1	3	4
Grade IIIb (intervention with GA)	3 (4.2%)	3 (3.8%)	6 (4.0%)
Reoperation for anastomotic leak	1	2	3
Reintervention for postoperative hemorrhage	1	1	2
Re-exploration for obstruction / afferent loop syndrome	1	0	1
Grade IV (life-threatening, ICU)	0	0	0
Grade V (death within 30 days)	2 (2.8%)	3 (3.8%)	5 (3.3%)

Billroth I group and 10.3 days in the Billroth II/Roux-en-Y group. Readmissions within 30 days occurred in 14 patients (9.3%): 5 in the Billroth I group and 9 in the Billroth II/Roux-en-Y group. Mortality within 30 days was recorded in 5 patients (3.3%), of which 2 occurred in the Billroth I group and 3 in the Billroth II/Roux-en-Y group (*Table 4*).

Quality of life outcomes assessed by the EORTC QLQ-STO22 questionnaire revealed that dysphagia mean scores at baseline were 20.6 ± 8.2 in the Billroth I group and 23.7 ± 7.9 in the Billroth II/Roux-en-Y group. At three months, the scores were 27.8 ± 9.6 and 31.3 ± 9.3, respectively, and at six months, 16.6 ± 10.8 and 18.8 ± 10.0. Pain scores at baseline were 24.5 ± 8.9 and 24.7 ± 8.2, at three months 34.9 ± 9.9 and 34.4 ± 9.6, and at six months 22.8 ± 11.8 and 21.7 ± 12.0. Reflux scores at baseline were 17.6 ± 7.3 and 26.1 ± 6.7, at three months 24.5 ± 9.2 and 36.5 ± 8.5, and at six months 14.7 ± 9.7 and 27.2 ± 9.1. Eating restriction scores at baseline were 27.1 ± 9.6 and 29.2 ± 8.5, at three months 39.4 ± 11.2 and 43.3 ± 10.9, and at six months 22.6 ± 11.9 and 29.4 ± 12.1. Anxiety scores at baseline were 40.2 ± 12.8 and 41.8 ± 11.6, at three months 49.3 ± 13.7 and 51.3 ± 12.5, and at six months 39.5 ± 15.3 and 41.1 ± 13.8. Dry mouth scores at baseline were 28.4 ± 11.9 and 29.1 ± 11.3, at three months 34.1 ± 12.5 and 35.4 ± 12.7, and at six months 26.0 ± 12.2 and 27.1 ± 11.9. Taste problem scores at baseline were 20.3 ± 9.4 and 20.5 ± 9.6, at three months 27.5 ± 11.2 and 27.6 ± 10.9, and at six months 18.6 ± 10.7 and 18.9 ± 11.0. Body image scores at baseline were 15.2 ± 7.8 and 16.1 ± 8.2, at three months 26.9 ± 10.6 and 29.2 ± 11.0, and at six months 20.7 ± 9.9 and 22.1 ± 10.2. Hair loss scores at baseline were 5.2 ± 5.5 and 5.5 ± 5.9, at three months 11.8 ± 6.1 and 13.2 ± 6.3, and at six months

Table 4. Postoperative outcomes of the study population

VariableBillroth I	Billroth II/RY (n=72)	Total (n=78)	p-value (n=150)	
Any complication, n (%)	23 (31.9%)	25 (32.1%)	48 (32.0%)	1.000*
Clavien–Dindo grade				0.868*
0 (no complication)	49 (68.1%)	53 (67.9%)	102 (68.0%)	
I	9 (12.5%)	9 (11.5%)	18 (12.0%)	
II	9 (12.5%)	8 (10.3%)	17 (11.3%)	
IIIa	2 (2.8%)	5 (6.4%)	7 (4.7%)	
IIIb	3 (4.2%)	3 (3.8%)	6 (4.0%)	
Length of stay (days)	11.4	10.3	–	0.010**
30-day readmission, n (%)	5 (6.9%)	9 (11.5%)	14 (9.3%)	0.493*
30-day mortality, n (%)	2 (2.8%)	3 (3.8%)	5 (3.3%)	1.000*

*χ^2 ; **Mann–Whitney U

Table 5. Health-related quality of life (EORTC QLQ-STO22 scores, 0–100) by surgical reconstruction

Domain	Timepoint	Billroth I (n=72), mean ± SD	Billroth II/RY (n=78), mean ± SD	p-value
Dysphagia	Baseline (T0)	20.6 ± 8.2	23.7 ± 7.9	0.019*
	3 months (T1)	27.8 ± 9.6	31.3 ± 9.3	0.024*
	6 months (T2)	16.6 ± 10.8	18.8 ± 10.0	0.159**
Pain	T0	24.5 ± 8.9	24.7 ± 8.2	0.926**
	T1	34.9 ± 9.9	34.4 ± 9.6	0.784*
	T2	22.8 ± 11.8	21.7 ± 12.0	0.559*
Reflux	T0	17.6 ± 7.3	26.1 ± 6.7	<0.001*
	T1	24.5 ± 9.2	36.5 ± 8.5	<0.001*
	T2	14.7 ± 9.7	27.2 ± 9.1	<0.001*
Eating restrictions	T0	27.1 ± 9.6	29.2 ± 8.5	0.374**
	T1	39.4 ± 11.2	43.3 ± 10.9	0.033*
	T2	22.6 ± 11.9	29.4 ± 12.1	0.001*
Anxiety	T0	40.2 ± 12.8	41.8 ± 11.6	0.416*
	T1	49.3 ± 13.7	51.3 ± 12.5	0.352*
	T2	39.5 ± 15.3	41.1 ± 13.8	0.512*
Dry mouth	T0	28.4 ± 11.9	29.1 ± 11.3	0.558*
	T1	34.1 ± 12.5	35.4 ± 12.7	0.406*
	T2	26.0 ± 12.2	27.1 ± 11.9	0.356*
Taste problems	T0	20.3 ± 9.4	20.5 ± 9.6	0.910*
	T1	27.5 ± 11.2	27.6 ± 10.9	0.948*
	T2	18.6 ± 10.7	18.9 ± 11.0	0.950**
Body image	T0	15.2 ± 7.8	16.1 ± 8.2	0.440*
	T1	26.9 ± 10.6	29.2 ± 11.0	0.138*
	T2	20.7 ± 9.9	22.1 ± 10.2	0.239*
Hair loss	T0	5.2 ± 5.5	5.5 ± 5.9	0.393**
	T1	11.8 ± 6.1	13.2 ± 6.3	0.107*
	T2	7.9 ± 5.8	8.5 ± 6.1	0.243**

*t-test; **Mann–Whitney U

7.9 ± 5.8 and 8.5 ± 6.1 (*Table 5*).

The Billroth I group showed an increase in dysphagia scores from 20.6 ± 8.2 at baseline to 27.8 ± 9.6 at three months, followed by a decrease to 16.6 ± 10.8 at six months. The pain scores increased from 24.5 ± 8.9 at baseline to 34.9 ± 9.9 at three months and then decreased to 22.8 ± 11.8 at six months. The reflux scores increased from 17.6 ± 7.3 at baseline to 24.5 ± 9.2 at three months, then decreased to 14.7 ± 9.7 at six months. Eating restriction scores changed from 27.1 ± 9.6 at baseline to 39.4 ± 11.2 at three months, then declined to 22.6 ± 11.9 at six months. Anxiety scores increased from 40.2 ± 12.8 at baseline to 49.3 ± 13.7 at three months, then decreased to 39.5 ± 15.3 at six months. Dry mouth scores increased from 28.2 ± 11.2 at baseline to 34.5 ± 11.6 at three months, then declined to 27.2 ± 11.9 at six months. Taste problem scores increased from 18.7 ± 10.3 at baseline to 26.9 ± 11.0 at three months, then returned to 20.0 ± 11.8 at six months. The body image scores increased from 13.8 ± 7.8 at baseline to 23.2 ± 9.6 at three months and then decreased to 17.8 ± 10.1 at six months. Hair loss scores increased from 5.5 ± 4.7 at baseline to 14.3 ± 6.9 at three months, then decreased to 8.4 ± 6.5 at six months.

In the Billroth II/Roux-en-Y group, the dysphagia scores were 23.7 ± 7.9 at baseline, 31.3 ± 9.3 at three months, and 18.8 ± 10.0 at six months. The pain scores were 24.7 ± 8.2, 34.4 ± 9.6, and 21.7 ± 12.0. The reflux scores were 26.1 ± 6.7, 36.5 ± 8.5, and 27.2 ± 9.1. Eating restriction scores were 29.2 ± 8.5, 43.3 ± 10.9, and 29.4 ± 12.1. Anxiety scores were 41.8 ± 11.6, 51.3 ± 12.5, and 41.1 ± 13.8. Dry mouth scores were 27.1 ± 12.0, 32.8 ± 13.2, and 25.3 ± 12.9. Taste problem scores were 18.9 ± 10.1, 26.8 ± 11.5, and 20.0 ± 11.8. Body image scores were 14.8 ± 7.2, 25.5 ± 8.7, and 19.7 ± 9.3. Hair loss scores were 4.8 ± 4.6, 12.5 ± 6.6, and 7.2 ± 6.1 (*Table 6, Figs.1-3*).

Discussions

The study used EORTC QLQ-STO22 to evaluate postoperative health-related quality of life (HRQoL) in gastric cancer patients who underwent gastroduodenal versus gastrojejunal reconstruction following gastrectomy. All patients included in this study underwent subtotal gastrectomy, allowing isolation of the reconstruction method's impact on postoperative quality of life. It is recognized that total gastrectomy has a greater influence on nutritional status and QoL scores, an aspect that

Table 6. Longitudinal changes in EORTC QLQ-STO22 domains (within-group analysis)

Domain	Group	Baseline (T0) mean ± SD	3 months (T1) mean ± SD	6 months (T2) mean ± SD	p-value
Dysphagia	Billroth I	20.6 ± 8.2	27.8 ± 9.6	16.6 ± 10.8	<0.001*
	Billroth II/RY	23.7 ± 7.9	31.3 ± 9.3	18.8 ± 10.0	<0.001*
Pain	Billroth I	24.5 ± 8.9	34.9 ± 9.9	22.8 ± 11.8	<0.001*
	Billroth II/RY	24.7 ± 8.2	34.4 ± 9.6	21.7 ± 12.0	<0.001*
Reflux	Billroth I	17.6 ± 7.3	24.5 ± 9.2	14.7 ± 9.7	<0.001*
	Billroth II/RY	26.1 ± 6.7	36.5 ± 8.5	27.2 ± 9.1	<0.001*
Eating restrictions	Billroth I	27.1 ± 9.6	39.4 ± 11.2	22.6 ± 11.9	<0.001*
	Billroth II/RY	29.2 ± 8.5	43.3 ± 10.9	29.4 ± 12.1	<0.001*
Anxiety	Billroth I	40.2 ± 12.8	49.3 ± 13.7	39.5 ± 15.3	<0.001*
	Billroth II/RY	41.8 ± 11.6	51.3 ± 12.5	41.1 ± 13.8	<0.001*
Dry mouth	Billroth I	28.2 ± 11.2	34.5 ± 11.6	27.2 ± 11.9	<0.001*
	Billroth II/RY	27.1 ± 12.0	32.8 ± 13.2	25.3 ± 12.9	<0.001*
Taste problems	Billroth I	18.7 ± 10.3	26.9 ± 11.0	20.0 ± 11.8	<0.001*
	Billroth II/RY	18.9 ± 10.1	26.8 ± 11.5	20.0 ± 11.8	<0.001*
Body image	Billroth I	13.8 ± 7.8	23.2 ± 9.6	17.8 ± 10.1	<0.001*
	Billroth II/RY	14.8 ± 7.2	25.5 ± 8.7	19.7 ± 9.3	<0.001*
Hair loss	Billroth I	5.5 ± 4.7	14.3 ± 6.9	8.4 ± 6.5	<0.001*
	Billroth II/RY	4.8 ± 4.6	12.5 ± 6.6	7.2 ± 6.1	<0.001*

*Within-group longitudinal change tested by Friedman test with Bonferroni-adjusted post-hoc contrasts (T0–T1, T1–T2, T0–T2). Between-group comparisons at each timepoint are reported in Table 5.

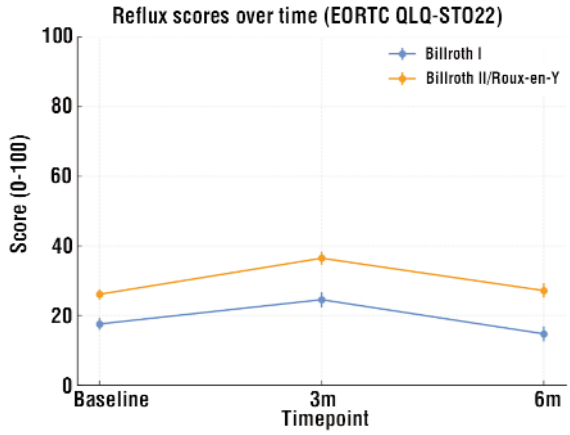

Figure 1. Longitudinal changes in EORTC QLQ-STO22 – REFLUX

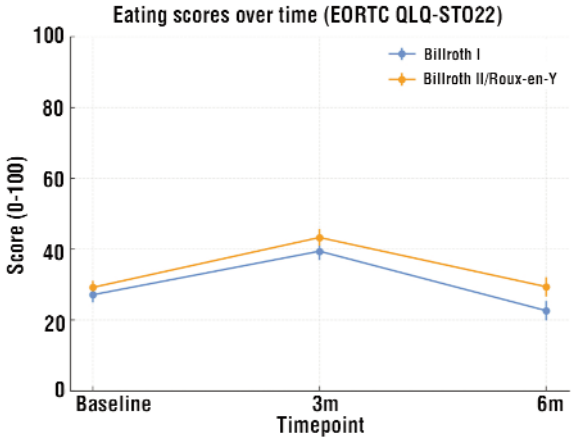

Figure 2. Longitudinal changes in EORTC QLQ-STO22 – EATING

warrants separate analysis in future studies. The findings indicated that both reconstruction methods resulted in a temporary decrease in HRQoL at three months, which improved partially at six months. The gastrojejunal reconstructions were associated with more severe reflux symptoms and eating restrictions, while the gastroduodenal anastomosis was associated with more favorable functional outcomes when technically feasible.

Our results confirm that gastric cancer, despite advances in detection and therapy, remains a significant cause of morbidity and mortality (1-4). Surgical resection stands as the only treatment that can cure the disease (5), and the increasing emphasis on patient-reported outcomes has high-

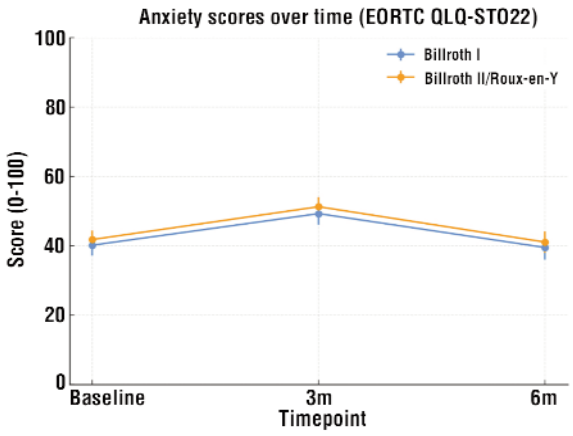

Figure 3. Longitudinal changes in EORTC QLQ-STO22 – ANXIETY

lighted the need to balance oncologic clearance with postoperative function (6). The oncological effectiveness of total gastrectomy has been confirmed by several studies, but this procedure results in significant nutritional impairment and poor HRQoL, which has driven interest in function-preserving techniques such as subtotal gastrectomy, proximal gastrectomy, and pylorus-preserving procedures (7-9). Randomized trials comparing minimally invasive versus open gastrectomy have similarly demonstrated that recovery profiles and QoL endpoints are at least as important as survival outcomes (10,11).

Previous research has emphasized the multidimensional effects of gastric cancer surgery on nutrition, gastrointestinal function, and physical recovery (12–15). The EORTC QLQ-STO22, in combination with the QLQ-C30, has become a widely validated tool for assessing HRQoL in this context (16–20). The psychometric validity of the instrument has been demonstrated repeatedly in gastrectomy patients, showing reliability in tracking changes over time and sensitivity to variations in surgical techniques (21–25). The STO22 was able to measure the transient perioperative decline in dysphagia, pain, reflux, and anxiety, as well as partial recovery in our cohort, which is consistent with previous validation studies.

The selection of reconstruction technique following distal gastrectomy has been a topic of much debate. The Billroth I procedure is considered to be the most „physiological" because it restores the normal anatomical continuity of the digestive tract. Our higher reflux burden in the gastrojejunal cohort appears discordant with reports indicating more endoscopic bile reflux and esophagitis after Billroth reconstructions when a Braun shunt is omitted. Two points may reconcile these findings. First, our Billroth II cases frequently received a Braun enteroenterostomy and our Roux-en-Y limb length was ≥40 cm, both of which mitigate bile reflux; in contrast, endoscopic series that favor higher reflux after Billroth I/II often lacked systematic Braun use or standardized Roux lengths. Second, our endpoint was patient-reported reflux symptoms (STO22), which does not perfectly correlate with endoscopic bile reflux. The direction and magnitude we observed are nevertheless consistent with several meta-analyses showing more favorable reflux symptoms with Billroth I when feasible and attenuation of bile reflux with RY vs classic BII. Differences in technique standardization and outcome definitions likely account for the apparent discrepancy across studies (26,27).

Our findings that patients undergoing Billroth I reconstruction had lower reflux and fewer dietary restrictions compared with Billroth II or Roux-en-Y reconstructions are in line with prior meta-analyses, which concluded that Billroth I is associated with better postoperative function when technically possible (26,27). When Billroth I is not possible due to tumor location or anatomical limitations, Billroth II and Roux-en-Y remain standard alternatives. Several studies and meta-analyses have demonstrated that Roux-en-Y reduces duodenogastric reflux compared with Billroth II, although at the cost of altered motility and potential Roux stasis (28–30). The data indicated that reflux symptoms were more frequent and severe in the gastrojejunal group, which included both Billroth II and Roux-en-Y reconstructions, indicating that jejunal reconstruction should be selected on an individual basis.

Notwithstanding numerous years of research, there is still no consensus on the best reconstruction technique to use after gastrectomy (32). The decision to reconstruct depends on several factors, including the tumor's location, stage, comorbidity burden, and surgeon experience (33). Moreover, the feasibility of laparoscopic subtotal gastrectomy with D2 lymphadenectomy for locally advanced disease, as validated in the KLASS-02 trial, has further reinforced the importance of individualized surgical planning that integrates both oncologic and functional endpoints (34,35).

The longitudinal patterns in our study are consistent with previous studies, with QoL generally getting worse in the early postoperative period before improving with recovery and adaptation (19,23,24). Nevertheless, persistent impairments were observed in domains such as reflux, eating restrictions, and body image, underscoring the long-term functional impact of gastrectomy. The clinical implications of these findings are significant because they emphasize the need for thorough preoperative education about postoperative changes as well as postoperative nutritional and psychological support programs to enhance recovery.

This study has several limitations. First, the prospective design improves internal validity, while the findings may not be generalizable beyond this single-center study. Second, the six-month follow-up period had limitations in capturing long-term changes in HRQoL. Fourth, we did not examine the impact of adjuvant chemotherapy on HRQoL measures such as hair loss, taste

disturbances, and fatigue. Third, Practice patterns vary—some centers default to Roux-en-Y to minimize duodenogastric reflux. Our strategy prioritized Billroth I when a tension-free, perfused gastroduodenostomy with adequate margins was achievable, reserving Billroth II/RY otherwise. This pragmatic selection may enrich the gastrojejunal group with more complex anatomy/comorbidity, which we addressed by reporting baseline balance and performing sensitivity analyses

Although Roux-en-Y reconstruction represents the current international standard after total or subtotal gastrectomy, Billroth-type reconstructions may still be encountered in selected distal or lower-body tumors when anatomical and oncological conditions allow. Our results should therefore be interpreted within this pragmatic institutional context.

Despite these limitations, the study provides valuable information about the impact of reconstruction methods on quality of life following gastrectomy for gastric cancer and highlights the utility of using standardized patient-reported measures such as the EORTC QLQ-STO22 in clinical practice.

Conclusion

Both reconstructions were associated with a transient deterioration in HRQoL and partial recovery by 6 months. Reflux-related symptoms and eating restrictions were higher after gastrojejunal reconstruction, whereas other domains were broadly comparable. Given technique-dependent variability (Braun shunt, Roux limb length) and selection factors, Billroth I may be favored when oncologically and technically feasible, while Roux-en-Y remains a robust alternative when a tension-free gastroduodenostomy cannot be achieved. Multicenter studies with standardized techniques and longer follow-up are warranted.

Conflict of Interest

The authors declare no conflicts of interest.

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