

Evaluation of Long-Term Outcomes After Total Gastrectomy for Gastric Cancer: A Comparative Analysis of Hand-Sewn Versus Mechanical Esophagojejunostomy

Evgeny A. Toneev^{1,2*}, Nikita A. Berestov², Danil D. Prokhorov^{1,2}, Maria A. Sypalo³, Polina A. Nevedomskaia³, Adel F. Rysaev³, Eleonora A. Mitina³

¹*Ulyanovsk Regional Clinical Oncology Dispensary, Ulyanovsk, Russia*

²*Ulyanovsk State University, Ulyanovsk, Russia*

³*Samara State Medical University, Samara, Russia*

Abstract

Background: Total gastrectomy remains a key component of gastric cancer treatment, and the method used to construct the esophagojejunostomy may influence long-term functional outcomes and quality of life. Evidence comparing hand-sewn and mechanical anastomoses in this context remains inconsistent. This retrospective study aimed to evaluate and compare long-term functional outcomes and quality of life in patients undergoing total gastrectomy with either hand-sewn or mechanical esophagojejunostomy.

Methods and Results: The study included 153 patients who underwent total gastrectomy for histologically confirmed gastric adenocarcinoma. Patients were divided into two groups based on the anastomotic technique: mechanical circular stapler or hand-sewn anastomosis (according to a patented method). Long-term outcomes were evaluated 12 months postoperatively using EORTC QLQ-C30 and QLQ-STO22 questionnaires, along with endoscopic assessment of reflux esophagitis using the Los Angeles classification. Postoperative complications were graded according to the Clavien–Dindo classification.

Both groups demonstrated comparable short-term postoperative outcomes and similar complication rates according to the Clavien–Dindo classification. However, patients with a hand-sewn anastomosis showed significantly better long-term quality-of-life scores (*EORTC QLQ-C30*, *QLQ-STO22*), including higher functional domain scores and lower scores for reflux, pain, nausea, and dietary restriction. Endoscopic assessment revealed no significant differences in esophagitis prevalence or severity between groups.

Conclusion: While mechanical anastomosis offers advantages in operative duration and blood loss, the hand-sewn technique provides superior long-term functional outcomes and quality-of-life benefits. These findings support the consideration of hand-sewn esophagojejunostomy in clinical settings where long-term recovery and patient-reported outcomes are prioritized. (**International Journal of Biomedicine. 2026;16(1):41-45.**)

Keywords: gastrectomy • quality of life • esophagojejunostomy • hand-sewn anastomosis, mechanical anastomosis • complications

For citation: Toneev EA, Berestov NA, Prokhorov DD, Sypalo MA, Nevedomskaia PA, Rysaev AF, Mitina EA. Evaluation of Long-Term Outcomes After Total Gastrectomy for Gastric Cancer: A Comparative Analysis of Hand-Sewn Versus Mechanical Esophagojejunostomy. *International Journal of Biomedicine*. 2026;16(1):41-45. doi:10.21103/Article16(1)_OA4

Introduction

Gastric cancer remains one of the leading causes of cancer-related mortality worldwide, ranking fifth in incidence and fourth in mortality among malignant tumors.¹ Despite a decline in incidence in several countries, the prognosis for advanced-stage disease remains unfavorable.² In Russia, gastric cancer consistently ranks among the ten most common

oncological diseases.³ Surgical treatment remains the main and essential component of multimodal therapy, providing acceptable long-term oncological outcomes. One of the radical treatment options is total gastrectomy. A crucial aspect of gastrectomy is the creation of the esophagojejunostomy, whose technique and reliability determine both early surgical outcomes and long-term functional results.² The use of mechanical stapling devices has standardized techniques and

reduced operative time. However, the discussion regarding the advantages of the hand-sewn technique versus mechanical anastomosis remains open, particularly with respect to long-term quality-of-life outcomes.⁴ This study aimed to evaluate and compare long-term functional outcomes and quality of life in patients undergoing total gastrectomy with either hand-sewn or mechanical esophagojejunostomy.

Materials and Methods

The retrospective study of total gastrectomy was conducted in 153 patients at the Ulyanovsk Regional Clinical Oncology Dispensary from 01.01.2019 to 01.09.2025.

The study included patients with morphologically confirmed gastric adenocarcinoma who underwent total gastrectomy, were aged 18 to 85 years, had no distant metastases, and had provided written informed consent. Exclusion criteria: patients who underwent emergency surgery, had high anesthetic risk (ASA IV–V), had a history of prior gastric surgery, or refused to participate.

Patients were divided into two groups based on the method of esophagojejunostomy formation: mechanical (using a circular stapler) (Group 1) and hand-sewn (Group 2), as described in the proposed technique. An esophagojejunostomy using a mechanical circular stapler was performed according to standard technique. After preparation of the Roux limb, a jejunojunctionostomy was performed; the limb was passed through an avascular window in the transverse mesocolon, and the esophagojejunostomy was created with a circular stapler. The staple line was additionally reinforced with 4–5 interrupted esophagojejunal sutures using PDS 3-0. The hand-sewn esophagojejunostomy was formed using the authors' patented technique (Russian Federation).⁵ An absorbable braided PGA 3-0 suture (MiM, Russia) with an atraumatic needle was used as follows: After completing a gastrectomy and D2 lymphadenectomy, a Roux limb was created to restore gastrointestinal continuity. The jejunal loop was transected 20–25 cm distal to the ligament of Treitz. A mobile Roux limb 60 cm in length was formed according to anatomical considerations. After choosing the appropriate length, a side-to-side jejunojunctionostomy was created. During the transection of the stomach from the esophagus, a Satinsky clamp was applied to the esophagus. The esophagus was transected in stages (adventitia/muscular layer, followed by submucosal–mucosal layer) under the clamp. Two fixation sutures were placed on the blind end of the jejunum 2–3 cm from the edge, approximating the loop to the lateral surfaces of the esophagus. A small enterotomy (5–7 mm) was created 3–4 mm from the first suture line. The posterior wall was created with a row of five full-thickness interrupted sutures oriented “mucosa to mucosa.” Two “transition” stitches were then placed at the junction of the posterior and anterior lips, with needle entry and exit from the mucosal side of the jejunum and the esophagus. The anterior wall was constructed with seromuscular interrupted sutures: entry from the serosal side of the jejunum, then through the esophageal mucosa near its edge, and cranially exiting onto the adventitia. The final step was invagination of the anastomotic line using “saddle-shaped” P-sutures: needle entry from the serosa

of the jejunum, perpendicularly engaging the esophageal adventitia, and a third needle entry again through the serosa of the jejunum. As a result, the first row of anterior interrupted sutures was buried beneath the row of P-sutures. Assessment of long-term outcomes.

The primary endpoint was quality of life at 12 months, assessed using the EORTC QLQ-C30 and QLQ-STO22 questionnaires.

Secondary endpoints included postoperative complications (Clavien–Dindo classification) and endoscopic findings according to the Los Angeles classification (at 12 months).

Statistical analysis was performed using R version 4.2.2 and StatTech v. 4.1.2 (StatTech LLC, Russia). Baseline characteristics were summarized as frequencies and percentages for categorical variables and mean±standard deviation (SD) for continuous variables. Means of 2 continuous normally distributed variables were compared by an independent samples Student's t-test. The frequencies of categorical variables were compared using the chi-square test or Fisher's exact test (2-tailed), when appropriate. A value of $P < 0.05$ was considered significant.

Results

A comparative analysis of clinical and demographic characteristics, as well as intraoperative data, for patients with mechanical and hand-sewn esophagojejunostomies is presented in Table 1. When comparing the two groups, statistically significant differences were identified in operative duration (185.3±24.7 min vs. 224.8±29.4 min, $P < 0.001$), blood loss (281.5±78.2 mL vs. 318.7±88.9 mL, $P = 0.007$), and anastomosis formation time (18.2±4.8 min vs. 34.7±7.9 min, $P < 0.001$), indicating the advantages of the mechanical technique. The rate of anastomotic leakage was higher in the mechanical group (3.8% vs. 0%). However, the difference did not reach statistical significance ($P = 0.246$).

The frequency and pattern of complications according to the Clavien–Dindo classification did not differ significantly between the groups (Table 2). Most patients in both cohorts experienced no postoperative complications.

Quality-of-life indicators in patients after gastrectomy differed significantly between those who received a mechanical and those who received a hand-sewn anastomosis (Table 3). Patients in the hand-sewn anastomosis group demonstrated higher levels of physical and role functioning, as well as better overall quality of life. In addition, these patients experienced significantly lower rates of nausea/vomiting and pain. To assess specific symptoms related to the disease and surgical intervention, the EORTC QLQ-STO22 module was used. A comparative analysis of the indicators in the mechanical and hand-sewn anastomosis groups is presented in Table 4.

Patients with a hand-sewn anastomosis demonstrated significantly lower levels of dysphagia, reflux symptoms, dietary restrictions, and pain, which reflects a more favorable long-term quality of life. The incidence of esophagitis according to the Los Angeles classification in the long-term follow-up period is presented in Table 5.

Table 1.

Clinical and demographic characteristics.

Parameter		Group1 (n=79)	Group 2 (n=74)	P-value
Age, years (M±SD)		66.5±12.8	61.8±12.2	0.021
Sex	Male, n (%)	59 (74.7%)	48 (64.9%)	0.218
	Female, n (%)	27 (34.2%)	26 (35.1%)	
The ASA physical status classification system	I, n (%)	8 (10.1%)	6 (8.1%)	0.782
	II–III, n (%)	71 (89.9%)	68 (91.9%)	
Diabetes mellitus, n (%)		12 (15.2%)	6 (8.1%)	0.214
Ischemic heart disease, n (%)		28 (35.4%)	20 (27.0%)	0.298
Hypertension, n (%)		52 (65.8%)	43 (58.1%)	0.405
Charlson index (M±SD)		2.0±0.7	1.8±0.4	0.031
BMI (M±SD)		27.8±5.0	26.1±4.6	0.030
Tumor location, n (%)	Distal part	32 (40.5%)	37 (50.0%)	0,488
	Body	18 (22.8%)	15 (20.3%)	
	Cardia (Siewert III)	29 (36.7%)	22 (29.7%)	
T stage, n (%)	T1 8 (10,1%)	T1 3 (4.1%)	0.401	
	T2 9 (11,4%)	T2 4 (5.4%)		
	T3a 25 (31,6%)	T3a 28 (37.8%)		
	T3b 16 (20,3%)	T3b 21 (28.4%)		
	T4a 12 (15,2%)	T4a 10 (13.5%)		
	T4b 9 (11,4%)	T4b 8 (10.8%)		
N stage, n (%)	N0 28 (35.4%)	N0 30 (40.5%)	0.341	
	N1 18 (22.8%)	N1 22 (29.7%)		
	N2 27 (34.2%)	N2 20 (27.0%)		
	N3 6 (7.6%)	N3 2 (2.7%)		
M stage, n	M0 79 (100%)	M0 74 (100%)	1.000	
	M1 0 (0%)	M1 0 (0%)		
Completed 4 cycles of neoadjuvant chemotherapy, n (%)		62 (78.5%)	65 (87.8%)	0.137
Operation time, min (M±SD)		185.3±24.7	224.8±29.4	<0.001
Blood loss. mL (M±SD)		281.5±78.2	318.7±88.9	0.007
Anastomosis time, min (M±SD)		18.2±4.8	34.7±7.9	<0.001
Anastomotic leakage, n (%)		3 (3.8%)	0 (0%)	0.246

Table 2.

Complications according to the Clavien–Dindo classification.

Grade	Group 1 (n=79)	Group 2 (n=74)	P-value
Grade 0–I	61 (77.2%)	56 (75.7%)	0.851
Grade II	12 (15.2%)	10 (13.5%)	0.821
Grade IIIA	2 (2.53%)	3 (4.05%)	0.673
Grade IIIB	1 (1.27%)	2 (2.70%)	0.610
Grade IVA	0 (0.0%)	2 (2.70%)	0.232
Grade IVB	1 (1.27%)	0 (0.0%)	1.000
Grade V	2 (2.53%)	1 (1.35%)	1.000

Table 3.

Quality of life according to the EORTC QLQ-C30 at 12 months after surgery.

Scale	Group 1 (n=42)	Group 2 (n=38)	P-value
Physical functioning	76.8±15.1	82.3±13.5	0.024
Role functioning	73.2±18.4	79.8±16.7	0.041
Global quality of life	70.9±17.4	77.1±15.6	0.034
Nausea/vomiting	26.2±12.5	19.7±10.8	0.002
Pain	23.4±10.2	17.9±8.7	0.001

Table 4.**Quality of life according to the EORTC QLQ-STO22 at 12 months after surgery.**

Scale	Group 1 (n=42)	Group 2 (n=38)	P-value
Reflux symptoms	21.4±10.7	14.6±8.3	0.002
Dietary restrictions	24.3±12.8	18.9±10.4	0.043
Specific pain	20.1±10.3	15.7±8.9	0.045

Table 5.**Endoscopic assessment according to the Los Angeles classification.**

Esophagitis grade	Group 1 (n=70)	Group 2 (n=68)	P-value
N (normal)	48 (68.6%)	41 (60.3%)	0.212
A (mild)	12 (17.1%)	15 (22.1%)	0.386
B (moderate)	6 (8.6%)	8 (11.8%)	0.532
C (severe)	3 (4.3%)	3 (4.4%)	0.988
D (very severe)	1 (1.4%)	1 (1.5%)	0.973
Any A–D	22 (31.4%)	27 (39.7%)	0.212
Clinically significant (C–D)	4 (5.7%)	4 (5.9%)	0.974

No statistically significant differences were found between the groups in terms of the frequency or severity of esophagitis. Most patients in both groups showed no signs of esophagitis, and clinically significant changes (grades C–D) were observed only in a small number of cases.

Discussion

The results of the present study demonstrate that long-term quality-of-life outcomes after gastrectomy in patients with gastric cancer are no less important than the immediate surgical results.^{6,7} A comparative analysis of clinical and demographic characteristics confirmed comparability between the groups on key parameters (age, sex, functional status), thereby excluding the influence of systematic differences on the results. At the same time, the use of mechanical anastomosis was associated with a statistically significant reduction in operative time and intraoperative blood loss, consistent with results reported by other authors.^{8,9} These advantages make stapling technologies convenient for surgeons, as they are highly reproducible and reduce operative trauma; however, their impact on long-term outcomes remains a matter of debate.¹⁰

Analysis of complications according to the Clavien-Dindo classification showed no statistically significant differences between the groups.¹¹ The rate of severe complications was low, which is consistent with international data.^{12,13} Russian publications also emphasize that the surgical center's experience and standardized technique are key factors in reducing postoperative mortality.¹⁴ Nevertheless, studies report statistically significantly higher complication rates in the hand-sewn anastomosis group.¹⁵

Currently, quality of life is considered an important indicator of treatment effectiveness. Great attention is paid to this aspect to improve patient well-being, functional capacity, and overall quality of life. Standardized questionnaires allow direct comparison of treatment outcomes across different surgical centers and techniques.¹⁶ The differences observed in the EORTC QLQ-C30 domains in our study are consistent with findings reported by other authors: the severity of symptoms and subjective outcomes after gastrectomy significantly depend on the type of reconstruction and the anatomical configuration of the anastomosis. In several variants, more frequently stapled ones, more pronounced gastrointestinal symptoms (reflux, discomfort) have been described, whereas global functional indicators may remain comparable.¹⁷ This confirms that the technical simplicity of a procedure is not always associated with better subjective outcomes.

The QLQ-STO22 results further clarified the picture, demonstrating statistically more severe reflux symptoms and dietary restrictions in patients with mechanical anastomosis.^{18,19} Endoscopic evaluation using the Los Angeles classification revealed a low incidence of severe esophagitis, with no significant differences between the groups. However, the correlation between endoscopic findings and questionnaire results (QLQ-STO22) suggests that functional disorders (dysphagia, reflux symptoms, and others) may have greater clinical significance for the patient than morphological changes. This observation is also reflected in several Russian and international publications.^{20–24} The use of multiple questionnaires to assess subjective patient-reported outcomes, combined with instrumental diagnostic methods such as upper endoscopy, enables a comprehensive evaluation of quality of life and ultimately provides a complete picture of the effectiveness of the proposed anastomotic technique.

Thus, the results of the study demonstrate that the choice of anastomosis technique affects long-term functional outcomes. The hand-sewn technique showed better quality-of-life indicators, as assessed by both subjective and objective methods, making it preferable when long-term outcomes are prioritized, namely, a minimal risk of anastomosis-related complications, including anastomotic leakage and reflux esophagitis. At the same time, mechanical anastomosis remains valuable due to reduced operative time and blood loss, which may be critically important for frail patients. In clinical practice, the choice of technique should be determined not only by the surgical center's technical capabilities but also by the anticipated impact on long-term quality-of-life outcomes.

In conclusion, when comparing hand-sewn and mechanical methods of anastomosis formation, both demonstrated comparable early postoperative outcomes; however, in the long-term period, the hand-sewn method provides superior quality of life.

Ethical Statement

The study was performed in accordance with the principles of the Declaration of Helsinki and approved by the local ethics committee (No. 12, dated 10.01.2025). All patients signed informed consent for the procedure.

References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA Cancer J Clin.* 2021 May;71(3):209-249. doi: 10.3322/caac.21660.
2. Lordick F, Carneiro F, Cascinu S, Fleitas T, Haustermans K, Piessen G, Vogel A, Smyth EC; ESMO Guidelines Committee. Gastric cancer: ESMO Clinical Practice Guideline for diagnosis, treatment and follow-up. *Ann Oncol.* 2022 Oct;33(10):1005-1020. doi: 10.1016/j.annonc.2022.07.004. PMID: 35914639.
3. Kaprin AD, Starinsky VV, Shakhzadova AO (eds.). Malignant neoplasms in Russia in 2021 (morbidity and mortality). Moscow: Hertsen Moscow Oncology Research Institute – Branch of the National Medical Research Radiology Centre, Ministry of Health of Russia, 2022. [In Russian].
4. Honório FCC, Tustumi F, Pinheiro Filho JEL, Marques SSB, Glina FPA, Henriques AC, Dias AR, Waisberg J. Esophagojejunostomy after total gastrectomy: A systematic review and meta-analysis comparing hand-sewn and stapled anastomosis. *J Surg Oncol.* 2022 Jul;126(1):161-167. doi: 10.1002/jso.26909. PMID: 35689590.
5. Toneev EA, Firsov AA, Martynov AA, Keshyan EA. Patent RU № 2836347. 2025. [In Russian].
6. Weimann A, Braga M, Carli F, Higashiguchi T, Hübner M, Klek S, et al. ESPEN practical guideline: Clinical nutrition in surgery. *Clin Nutr.* 2021 Jul;40(7):4745-4761. doi: 10.1016/j.clnu.2021.03.031. PMID: 34242915.
7. Pinheiro RN, Mucci S, Zanatto RM, Picanço Junior OM, Bottino AAG, Fontoura RP, Lopes Filho GJ. Quality of life as a fundamental outcome after curative intent gastrectomy for adenocarcinoma: lessons learned from patients. *J Gastrointest Oncol.* 2019 Oct;10(5):989–998. doi:10.21037/jgo.2019.06.05. PMID: 31602337.
8. Zhou ZG, Hu M, Li Y, et al. Stapled vs hand-sewn gastroenteric anastomosis after gastrectomy: randomized controlled trial. *World J Gastroenterol.* 2003;9(4):772–774.
9. Degiuli M, Elmore U, De Carli S, et al. Mechanical vs hand-sewn anastomosis after gastrectomy for cancer: a multicenter comparison. *World J Surg Oncol.* 2014;12:292.
10. Kvist E, Helminen O, Helmiö M, Huhta H, Jalkanen A, Junttila A, et al.; FINEGO group. Stapled vs handsewn anastomosis and anastomotic leaks in gastric cancer surgery—a population-based nationwide study in Finland. *J Gastrointest Surg.* 2024 Jun;28(6):820-823. doi: 10.1016/j.gassur.2024.03.005. PMID: 38599994.
11. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg.* 2004 Aug;240(2):205-13. doi: 10.1097/01.sla.0000133083.54934.ae. PMID: 15273542; PMCID: PMC1360123.
12. Katai H, Ishikawa T, Akazawa K, Isobe Y, Miyashiro I, Oda I, et al. Short-term surgical outcomes from the nationwide registry of the Japanese Gastric Cancer Association. *Gastric Cancer.* 2018;21(4):665–674.
13. Sano T, Sasako M, Yamamoto S, Nashimoto A, Kurita A, Hiratsuka M, et al. Mortality and morbidity after D2 gastrectomy for gastric cancer: an analysis of 2,500 patients. *Br J Surg.* 2004;91(8):1099–1104.
14. Toneev EA, Firstov AA, Keshyan EA, Pikin OV, Danilova LA, Martynov AA, Zhinov AV. Immediate surgical results of gastrectomies for gastric cancer: Experience of the regional oncology center. *Novosti Khirurgii [News of Surgery].* 2023;31(6):502–512. [In Russian].
15. Uprak TK, Ekdal DC, Ergenç M, Attaallah W, et al. “Hand-sewn versus Stapled Anastomosis for Billroth II Gastrojejunostomy After Distal Gastrectomy: Comparison of Short-term Outcomes.” *İstanbul Med J.* 2023;24(2):181-185.
16. van Amelsfoort RM, van der Sluis K, Schats W, Jansen EPM, van Sandick JW, Verheij M, Walraven I. Health-Related Quality of Life in Locally Advanced Gastric Cancer: A Systematic Review. *Cancers (Basel).* 2021 Nov 25;13(23):5934. doi: 10.3390/cancers13235934.
17. Yang K, Zhang WH, Liu K, Chen XZ, Zhou ZG, Hu JK. Comparison of quality of life between Billroth-I and Roux-en-Y anastomosis after distal gastrectomy for gastric cancer: A randomized controlled trial. *Sci Rep.* 2017 Sep 12;7(1):11245. doi: 10.1038/s41598-017-09676-2. Erratum in: *Sci Rep.* 2018 Apr 25;8(1):6783. doi: 10.1038/s41598-018-24612-8. PMID: 28900096; PMCID: PMC5595810.
18. Park KB, Park JY, Lee SS, Chung HY, Kwon OK. Chronological changes in quality of life and body composition after gastrectomy for locally advanced gastric cancer. *Ann Surg Treat Res.* 2020 May;98(5):262-269. doi: 10.4174/astr.2020.98.5.262.
19. Ito Y, Yoshikawa T, Fujiwara M, Kojima H, Matsui T, Mochizuki Y, et al. Quality of life and nutritional consequences after aboral pouch reconstruction following total gastrectomy for gastric cancer: randomized controlled trial CCG1101. *Gastric Cancer.* 2016 Jul;19(3):977-85. doi: 10.1007/s10120-015-0529-5. Epub 2015 Aug 14. PMID: 26272278.
20. Im MH, Kim DY, Kim YJ, Kim SH, Kim CW, Choi SH, et al. The impact of esophageal reflux-induced symptoms on quality of life after gastrectomy for gastric cancer. *J Gastric Cancer.* 2014;14(3):207–214. doi:10.5230/jgc.2014.14.3.207. PMID: 25364383; PMCID: PMC3996245.
21. Park SH, Man Yoon H, Ryu KW, Kim YW, Han M, Eom BW. Long-term Functional and Patient-reported Outcomes Between Intra-corporeal Delta-shaped Gastroduodenostomy and Gastrojejunostomy After Laparoscopic Distal Gastrectomy. *J Gastric Cancer.* 2023 Oct;23(4):561-573. doi: 10.5230/jgc.2023.23.e35. PMID: 37932223; PMCID: PMC10630562.
22. Maev IV, Andreev DN, Kucheryavy Yu A. Gastroesophageal reflux disease: current concepts of pathogenesis, diagnosis, and treatment. *Lechashchiy Vrach (The Attending Physician).* 2004;(4):12–17. [In Russian].
23. Solovyova GA, Ilchenko AA, Filippov Yu V, Andreev DN. Development and validation of the Russian version of the GERD-HRQL questionnaire for assessing quality of life in patients with gastroesophageal reflux disease. *Kachestvennaya Klinicheskaya Praktika (Quality Clinical Practice).* 2020;(2):45–51. [In Russian].
24. Sheptulin AA, Storonova OA, Rummyantseva SA. Classifications of reflux esophagitis and their clinical significance. *Endoskopicheskaya Praktika (Endoscopic Practice).* 2015;(2):34–39. [In Russian].