



ORIGINAL ARTICLE

**A Prospective Study Comparing Billroth II and Roux-en-Y Gastrojejunostomy in Patients with Carcinoma Stomach**

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**Abstract**

**Aims and objectives:** Comparison of the outcome of Roux-en-Y & Billroth II gastrojejunostomy in patients with gastric cancer specifically in terms of nutrition, gastric emptying and quality of life.

**Methods:** All good performance status patients (ECOG  $\leq 2$ ) aged less than 75 years old with distal gastric carcinoma presenting to the Department of GI Surgery, AIIMS, New Delhi between November 2012 and December 2013 were evaluated prospectively for inclusion in the study. Roux-en-Y gastrojejunostomy or Billroth II gastrojejunostomy was planned after distal gastrectomy and Billroth II gastrojejunostomy only in unresectable patients. Assessment was done 3 months after surgery.

**Results:** Thirty patients were recruited in the study. Twenty-four patients were offered distal resection. Roux-en-Y reconstruction was done in 16 patients & Billroth II reconstruction in 8 patients. Six unresectable cases were offered palliative Billroth II bypass only. Comparison of Roux-en-Y vs Billroth II gastrojejunostomy revealed following results. In the postoperative period, mean duration of nasogastric tube drainage and mean onset of regular oral diet were  $3 \pm 0.8$  days vs  $4.5 \pm 2$  days and  $6.2 \pm 2.2$  days vs  $8.8 \pm 3.9$  days respectively. At 3 months of follow up, physical parameters of WHOQOL-BREF assessment revealed score of  $10.2 \pm 1.4$  vs  $8.2 \pm 2.5$  respectively.

**Conclusion:** Reconstruction in patients with gastric cancer in the form of Roux-en-Y & Billroth II gastrojejunostomy revealed favourable short-term results like removal of nasogastric tube drain and initiation of enteral nutrition; and physical parameters of quality of life at the end of the third month. Rest of the results were similar in both groups.

**Keywords:** Roux-en-Y gastrojejunostomy, Billroth II gastrojejunostomy, Gastric emptying, WHOQOL-BREF.

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## Introduction

Gastric cancer is one of the common cancers of the digestive system. In the year 2008, 989,600 new cases were detected and 738,000 deaths were estimated to have occurred globally due to gastric cancer. Over 70% of new cases and deaths occur in developing countries. The highest incidence is in Eastern Asia, Eastern Europe and South America and the lowest rates in North America and Africa [1]. In USA, about 21,000 new cases are detected each year, and 10,570 deaths related to gastric cancer occur [2]. In India, the age-adjusted rate is 4.6–11.1 per 100,000 population, with the incidence being more in the southern states [3].

Worldwide, gastric cancer is commonly seen in the antrum/body of the stomach and requires a distal/subtotal gastrectomy. In western countries, the proximal stomach is the most common site requiring a total or proximal gastrectomy. Distal or subtotal gastric resection is followed by one of the reconstructive procedures like gastro-duodenal anastomosis (Billroth I), loop gastrojejunal anastomosis (Billroth II), or a Roux-en-Y gastrojejunostomy. The more commonly performed reconstructions are Billroth II and Roux-en-Y gastrojejunostomy. The choice of reconstructive procedure after distal/subtotal gastrectomy for gastric cancer remains controversial. Billroth II reconstruction requires a single anastomosis and is technically simpler, but has been shown to have bile reflux into the gastric remnant by some authors, causing histological alterations in the gastric mucosa and a clinical syndrome called alkaline gastritis. It may also be associated with afferent limb complications like afferent loop syndrome. Roux-en-Y gastrojejunostomy requires two anastomoses and may be associated with complications like Roux stasis syndrome.

In a randomized controlled trial, Csendes et al. compared the results of Billroth II and Roux-en-Y gastrojejunostomy after distal gastrectomy for peptic ulcer disease [4]. The Roux-en-Y gastrojejunostomy group had significantly better clinical results than Billroth II reconstruction, in terms of less symptoms of gastroesophageal reflux. Also, after Billroth II anastomosis endoscopy showed the presence of erosive esophagitis and Barrett's metaplasia more frequently than after a Roux-en-Y reconstruction. The Visick grading showed a significantly better result after Roux-en-Y

reconstruction ( $P < 0.001$ ).

Fukuhara et al., in a retrospective study, observed that bile reflux periods in the gastric remnant and esophagus were significantly less with Roux-en-Y reconstruction than with Billroth II and Billroth I reconstruction after distal gastrectomy for gastric cancer, [5]. They also found a correlation between the incidence of reflux symptoms and the duration of reflux exposure. Mine et al. found the incidence of early and late dumping to be significantly less with Roux-en-Y than with other forms of reconstruction in patients with gastric cancer [6].

In peptic ulcer surgery it has been shown that Roux-en-Y gastrojejunal reconstruction is superior to Billroth II anastomosis, but in gastric cancer few studies have compared Billroth I with Roux-en-Y gastrojejunostomy, and there are no studies with a head-to-head comparison between Billroth II gastrojejunostomy and Roux-en-Y gastrojejunostomy.

## Aims and Objectives

The aim of this study was to compare the outcome of Billroth II and Roux-en-Y gastrojejunostomy in patients with gastric cancer specifically in terms of nutrition, gastric emptying and quality of life.

## Methods

All patients with carcinoma of the stomach presenting to the Department of Gastrointestinal Surgery, All India Institute of Medical Sciences, New Delhi between November 2012 and December 2013 were evaluated for inclusion in the study. This study was registered in clinical trials registry of India (CTRI/2013/11/004126).

## Inclusion Criteria

1. Age <75 years
2. Adenocarcinoma of stomach body/antrum
3. Good performance status, i.e., Eastern Cooperative Oncology Group (ECOG) grades 0, 1 and 2

## Exclusion Criteria

1. Patients who refused to give consent for the study
2. Comorbid conditions which would preclude gastrectomy
3. Patients with previous gastrectomy

4. Patients with stomach cancer or previous small bowel surgery precluding either form of reconstruction

### Staging

All patients assessed for inclusion in the trial were evaluated with a detailed history and complete clinical examination. Patients were investigated with complete blood counts, renal and liver function tests, serum electrolytes, blood sugar, chest X-ray and electrocardiogram. The performance status was assessed using the ECOG scale [7]. Tumor assessment was done by upper GI endoscopy and staging was done by CECT scan. TNM Staging was done as per AJCC 7th edition [8].

### Surgery

Patients diagnosed with distal gastric cancers after evaluation and informed consent were enrolled in the study and underwent subtotal gastrectomy depending on the location and extent in resectable cases and palliative bypass in unresectable/advanced cases.

Patients underwent Billroth II gastrojejunostomy in one arm using a jejunal loop with a short afferent limb in an iso-peristaltic manner in either antecolic or retrocolic position and in the other arm patients underwent Roux-en-Y gastrojejunostomy using a jejunal limb length of 15–20 cm distal to the duodenojejunal flexure, and a Roux limb length of 45 cm. The type of reconstruction was chosen by the operating surgeon. Feeding jejunostomy was done using a 12 Fr Malecot tube by Witzel's method. Postoperative complications were noted. Operative mortality was defined as death from any cause within 30 days of surgery or during the same hospital admission.

### Follow up

All patients were assessed at the visit 3 months after surgery. Apart from a complete clinical evaluation to rule out recurrence or metastasis, gastric emptying scan was done. Clinical symptoms such as epigastric pain, heartburn, bilious vomiting, postprandial bloating and nausea were recorded in both the groups. An assessment of the daily intake of calorie and protein was done by an experienced dietician. Nutritional status was assessed by measuring the weight in kilograms, BMI in

kg/m<sup>2</sup>. Serum albumin, also a nutritional parameter, was measured both preoperatively and at 3 months postoperatively. Post-operative adjuvant treatment was given in advanced and node positive disease.

### Gastric emptying study

This was done using a radionuclide gastric emptying scan. The patient was kept nil per oral for a minimum of 4 hours prior to the study. Steamed rice cake (Idli) prepared from a commercially available ready-mix rice powder (Gits, India) was used. Each packet contained 200 g of ready-mix rice powder which was dissolved in 320 ml of water. A total of 15-20 mCi of Tc99m sulphur colloid was added to the mixture. The Mixture was steamed after putting it in moulds thereby making 18 pancakes of 30 g each. Patients were encouraged to consume the meal within 10 minutes. The images were in a format of 64 x 64 pixels using a low-energy high-resolution collimator. Photopeak settings were at 20% at 140 keV for Tc99m. At the end of consumption of the rice cake, the first image was obtained. Subsequent images were taken every 15 minutes for at least 60 minutes. Data was analysed with gastric emptying software and the result was expressed as emptying half time (t<sub>1/2</sub>) in minutes. The emptying half time (t<sub>1/2</sub>) was compared between both groups. The total amount of radiation exposure was around 0.5 mSv per study.

### Quality of life

Quality of life assessment was done using WHOQOL-BREF at baseline and at 3 months postoperatively. DAUGS 20 was used postoperatively at 3 months.

### Results

A total of 51 patients with biopsy proven distal gastric carcinoma were evaluated between November 2012 and December 2013. Out of these, 21 patients were excluded due to various reasons. The 30 patients included in this study underwent either a Roux-en-Y gastrojejunostomy [*n* = 16 (53.3%)] or a Billroth II gastrojejunostomy [*n* = 14 (46.7%)]. Curative gastrectomy was possible in 20 patients. Palliative gastrectomy was done in 4 patients and gastrojejunostomy to bypass the unresectable gastric cancer was done in 6 patients (Fig. 1).

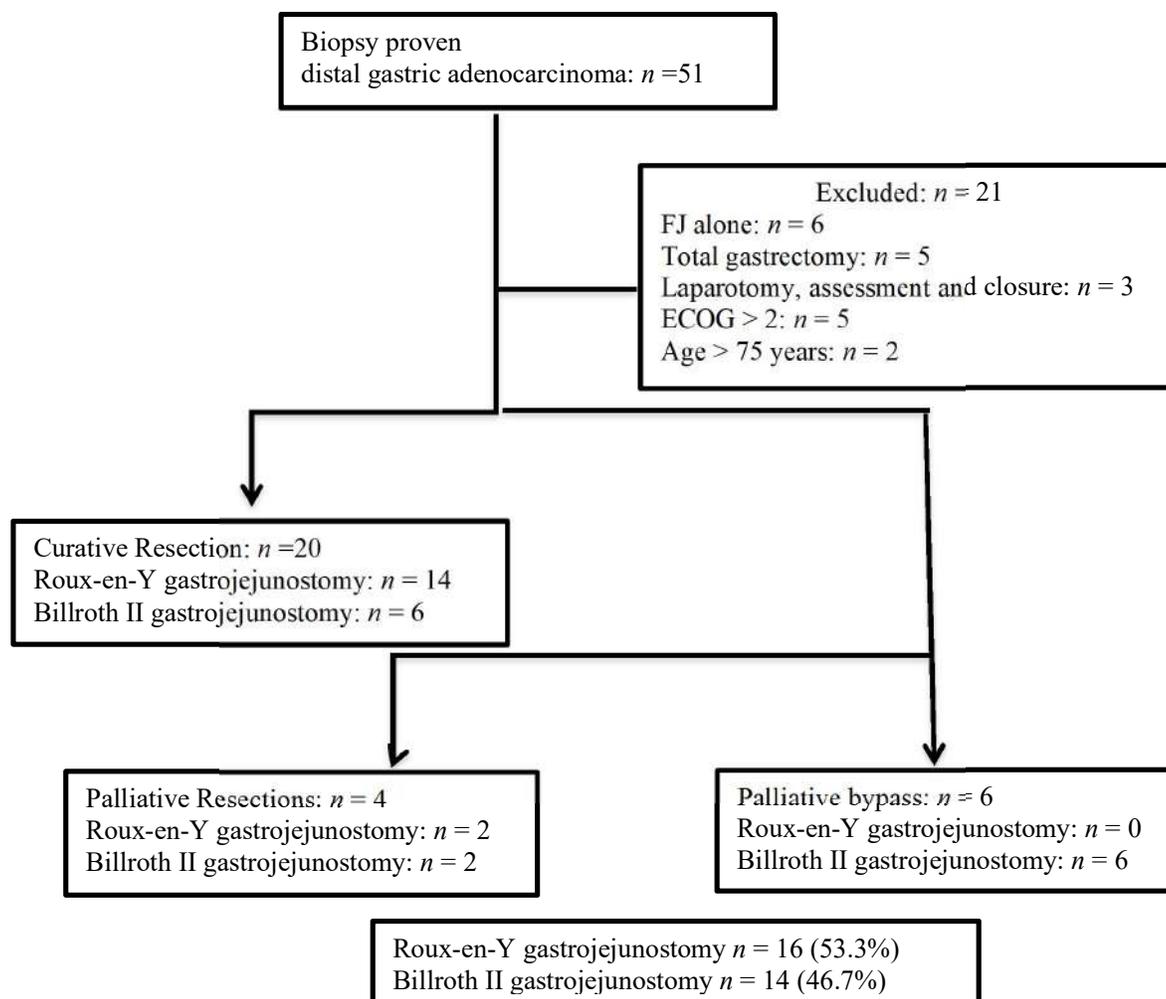


Fig. 1. Flow chart showing study allocation

**Patient Characteristics (Table 1)****Table 1. Characteristics of the patients**

Characteristics	Overall n = 30	Roux-en-Y n = 16	Billroth II n = 14	p-value
Age (years):				
Mean	55±12	54.9±12.8	55.6±11.6	0.8
Median	54	51	56.5	
Range	26-72	26-72	31-70	
Sex (%):				
Male	21 (70)	10 (62.5)	11 (78.6)	0.4
Female	9 (30)	6 (37.5)	3 (21.4)	
GI bleed (%)	13 (43.3)	7 (43.8)	6 (42.9)	1.0
Gastric outlet obstruction (%)	20 (66.7)	8 (50)	12 (85.7)	0.05
Pain (%)	18 (60)	11 (68.8)	7 (50)	0.4
Anorexia (%)	25 (83.3)	12 (75)	13 (92.9)	0.3
Weight loss (%)	26 (86.7)	12 (75)	14 (100)	0.1
Blood transfusion (%)	10 (33.3)	5 (31.3)	5 (35.7)	1.0
Mean BMI (kg/m <sup>2</sup> )	18.5±3.0	19±3.5	17±2.3	0.3

Serum albumin (g/dl)	3.5±0.7	3.6±0.8	3.3±0.7	0.3
ECOG:				
1	14	11	3	
2	16	5	11	0.01
Stage (%):				
IB	1 (3.3)	1 (6.3)	0	
IIA	1 (3.3)	1 (6.3)	0	
IIIB	5 (16.7)	4 (25)	1 (7.1)	
IIIA	2 (6.7)	1 (6.3)	1 (7.1)	
IIIB	6 (20)	3 (18.8)	3 (21.4)	
IIIC	6 (20)	4 (25)	2 (14.3)	
IV	9 (30)	2 (12.5)	7 (50)	0.3
Peritoneal metastases (%)	7 (23.3)	1 (6.2)	6 (42.8)	0.02
Ascites (%)	8 (26.7)	2 (12.5)	6 (42.8)	0.07
Liver metastases (%)	5 (16.7)	1 (6.2)	4 (28.5)	0.12
Locally advanced (%)	9 (30)	2 (12.5)	7 (50)	0.04

### Surgery and postoperative nutritional parameters (Table 2)

Out of the 30 patients who were subjected to gastric surgery, feeding jejunostomy was added in 17 patients (56.6%). Roux-en-Y reconstruction was done more commonly after curative resections than after palliative resections with a statistically significant difference ( $p = 0.001$ ). After subtotal gastrectomy, reconstruction with Roux-en-Y anastomosis was done in 16 patients

and with Billroth II gastrojejunostomy in 8 patients, which again was a statistically significant finding ( $p = 0.05$ ). Postoperatively, the mean duration of nasogastric tube drainage was  $3 \pm 0.8$  days in patients with Roux-en-Y gastrojejunostomy and was  $4.5 \pm 2$  days in the Billroth II group, which was statistically significant ( $p=0.02$ ). Resuming regular oral diet was significantly earlier in the Roux-en-Y group than the Billroth II group ( $6.2 \pm 2.2$  days vs.  $8.8 \pm 3.9$  days;  $p = 0.03$ ).

**Table 2. Surgery and postoperative nutritional parameters**

Parameter	Roux-en-Y n=16	Billroth II n=14	p-value
Surgery (%):			
Curative	14 (87.5)	6 (42.8)	
Palliative	2 (12.5)	8 (57.2)	0.01
Surgery (%):			
Resection	16 (100)	8 (57.1)	
Bypass	0	6 (42.9)	0.05
Mean nasogastric tube drainage (days)	$3 \pm 0.8$	$4.5 \pm 2$	0.02
Mean onset of regular oral diet (days)	$6.2 \pm 2.2$	$8.8 \pm 3.9$	0.03

**Follow up (Table 3)**

At follow up 3 months after surgery, 24 patients survived. The mean follow up was similar between both the groups ( $p = 0.2$ ). Clinical features such as reflux, dumping and early satiety were similar in both the groups ( $p = 0.2$ ). The mean DAUGS20 score, mean

change in body weight, the increase or decrease in mean serum albumin levels, the mean percentage of calorie intake and Visick grading were similar in both the groups. The T1/2 of gastric emptying time was also similar among both the groups.

**Table 3. Follow up parameters at 3 months after surgery**

Variable	Roux-en-Y	Billroth II	p-value
Mean follow up (months)	8±4.4	5.9±4.8	0.2
Symptoms (%):			0.2
Asymptomatic	8 (57.1)	6 (60)	
Reflux symptoms	1 (7.1)	1 (10)	
Dumping	0	2 (20)	
Early satiety	5 (35.5)	1 (10)	
Mean DAUGS20 score	19±3.4	22.5±3.8	0.5
Weight change (kg):			
Mean±SD	0.7±5.9	-2.1±5.8	0.1
Range	-8 to 12	-10 to 9	
Albumin difference (g/dl):			
Mean±SD	0.22±0.7	0.14±1	0.7
Range	-0.9 to 1.2	-1.5 to 1.8	
Mean Kcal intake (%)	80.5±27.4	76.2±28	0.9
Visick grade:			
1	8	2	0.17
2	5	6	
3	0	1	
4	3	5	
Gastric emptying time T1/2 (min):			
Mean±SD	46.2±13.9	27.7±3.3	0.29
Range	14 to 201	11 to 41	

**Quality of life (Table 4)**

The quality of life (QOL) was analysed between both the groups. All the domains in the preoperative period were similar. In the postoperative period, physical domain ( $p =$

0.01) was significantly better in the Roux-en-Y group but the other domains (psychological, social and environmental) were similar in both the groups.

**Table 4. Mean Scores of the WHOQOL-BREF assessment**

Domains	Preoperative QOL			Postoperative QOL 3 months after surgery		
	Roux-en-Y	Billroth II	p-value	Roux-en-Y	Billroth II	p-value
Physical	7.8±3.4	7.6±2.9	0.8	10.2±1.4	8.2±2.5	0.01
Psychological	8.3±3.1	8.5±3.6	0.8	9.1±3	9.8±3	0.5
Social	9.7±3.6	10.2±3.0	0.6	10.4±2.7	10.3±3.3	0.4
Environmental	8.9±3.4	8±2.5	0.4	9.6±2.3	8.9±2.7	0.4

## Discussion

There was a male predominance of the disease in our study; the male to female ratio was 2.3:1. Global cancer statistics shows that gastric cancer is one to two times more common among men [3,9].

We staged the tumor by using CT scan alone, though recent studies have also used laparoscopy for staging. Most of our patients presented with gastric outlet obstruction and GI bleed, and palliative resection or bypass was warranted in most of them. Curative distal gastrectomy was possible in 20 out of 30 patients (66.6%). Billroth II procedure was done more frequently than the Roux-en-Y anastomosis in our study patients with poorer performance status and unresectable lesion (bypass only), as the Billroth II procedure required a single anastomosis and was quicker. In a study by Burke et al. [10], the risk of finding peritoneal metastases at the time of laparotomy was 25–37% after an otherwise, unremarkable CT scan, which was similar to our study (23%).

The requirement for nasogastric tube drainage was significantly more in patients with Billroth II reconstruction ( $p = 0.02$ ) and onset of oral diet was significantly earlier in the Roux-en-Y group ( $p = 0.03$ ). While comparing Billroth I anastomosis and Roux-en-Y reconstruction, some studies from Japan have shown that the Roux-en-Y group had significantly prolonged delayed gastric emptying and time to resume oral intake (5,11), while other studies have shown that Roux-en-Y had better results [12]. In another randomized controlled study between Billroth II and Roux-en-Y reconstruction done for peptic ulcer disease, gastric atony was similar between both the groups [4].

In the present study at the end of 3 months, 23 patients survived and were available for evaluation. The patients in the Roux-en-Y group had a mean of  $0.7 \pm 5.9$  kg gain in body weight, and patients in the Billroth II group had a mean of  $-2.1 \pm 5.8$  kg change in the body weight when compared to the pre-operative body weight. Patients who had undergone curative resection had gained weight. Patients who had palliative surgery and who developed adjuvant therapy-related side-effects had weight loss. In a retrospective comparative study in patients with carcinoma of stomach by Fukuhara et al. [5], 34% of patients with Roux-en-Y reconstruction and 41% of patients with

Billroth II reconstruction had weight loss at 3 months postoperatively ( $p > 0.05$ ). Postoperative weight gain was also non-significant between the Roux-en-Y and Billroth II groups in peptic ulcer disease in the study by Csendes et al. [4].

On analysis of nutritional parameters at 3 months postoperatively, the Roux-en-Y group had better mean serum albumin levels and mean dietary calorie intake values than the Billroth II group, but these were not statistically significant ( $p = 0.7, 0.9$  respectively). Similar results were also seen in study by Imamura et al [13], done in gastric cancer patients where the average intake volume was compared with the preoperative value and was not significant between both the groups ( $p > 0.05$ ). In patients operated for peptic ulcer disease, Visick grading was significantly better in the Roux-en-Y group than the Billroth II group in the study by Csendes et al. [4]. In our study, Visick grading was similar in both the groups.

In western countries gastric emptying time was measured using chicken liver or low-fat, liquid egg white sandwich meal (14). As many of our patients are vegetarians and the dietary habits are different from the western countries, we used steamed rice cake (Idli) with 15-20 mCi of Tc99m sulphur colloid which has been previously standardized in our hospital. Though the emptying half time ( $T_{1/2}$ ) was prolonged in Roux-en-Y group, it was not statistically significant between both groups ( $p = 0.2$ ). Cohen AM et al., in their study found that the incidence of delayed gastric emptying after gastrectomy had been up to 20% [15].

We used WHOQOL-BREF in our study as it is validated in an Indian population and is available in Hindi. The baseline values of all the domains were similar in both groups. At follow up 3 months after surgery, the physical domain was significantly better after Roux-en-Y reconstruction ( $p = 0.01$ ). This may be because of the fact that two-thirds of our patients had either gastric outlet obstruction or gastrointestinal bleed. In some of the studies comparing Billroth I and Roux-en-Y reconstruction, there was no significant difference [16]. A nonrandomized retrospective comparison of Billroth I, Billroth II, and Roux-en-Y reconstruction 3 years after partial gastrectomy showed that Roux-en-Y resulted in a better QOL [17]. The Dysfunction After Upper Gastrointestinal Surgery - DAUGS 20 score, based on 7 factors, combined symptoms of gastroesophageal reflux, deglutition

difficulty, limitation of physical activity, diarrhea, dumping, transfer dysfunction and hypoglycaemic symptoms. Even though the score was better in Roux-en-Y reconstruction, it was not statistically significant ( $p=0.5$ ). In the study by Nakamura et al., which compared Billroth I and Roux-en-Y reconstruction, there was no significant difference [16].

### Conclusion

Following subtotal gastrectomy for distal gastric cancer, the reconstructive procedure of choice is debatable. Even though the Roux-en-Y gastrojejunostomy was proven to be superior in peptic ulcer disease, the results are mixed in carcinoma stomach. In this prospective study comparing Roux-en-Y gastrojejunostomy and Billroth II gastrojejunostomy after subtotal

gastrectomy for distal gastric cancer, despite the limitations, the short-term results like removal of nasogastric tube drain and initiation of enteral nutrition favoured Roux-en-Y gastrojejunostomy. However, at the end of the third month, except for improvement in the physical parameters of quality of life, the other quality of life parameters and nutritional parameters were similar in both the groups.

### Statements and Declarations

#### Conflicts of interest

The authors declares that they do not have conflict of interest.

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