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Gastric substitute after total gastrectomy – clinical relevance for reconstruction techniques

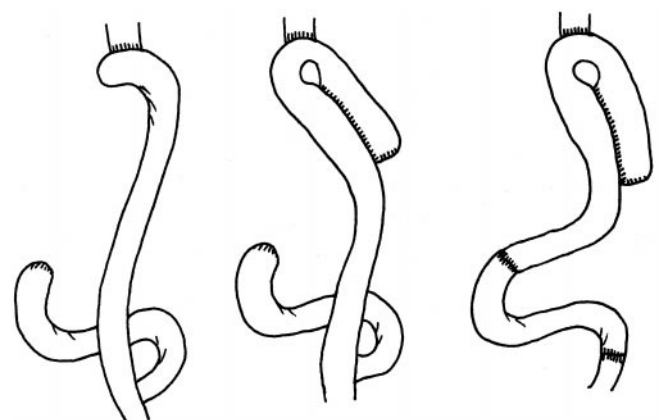
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Abstract *Background:* More than 60 different methods of reconstruction after total gastrectomy have been described. The different surgical procedures can be reduced essentially to pouch reconstruction, pouch size and maintenance of duodenal passage. *Methods:* To clarify the importance of pouch reconstruction and maintenance of duodenal passage, we reviewed all controlled prospectively randomized clinical studies reporting on the various methods of reconstruction after gastrectomy. *Results:* After reconstruction with a pouch, 6-month postoperative patients have a better food intake, a slower food passage ($t_{50\%}$ 12 vs 25 min), fewer postprandial symptoms (4–10% vs 20–60%), less weight loss (7 vs 14kg), and in tendency, they have a better quality of life. With maintenance of duodenal passage, disturbance of blood sugar regulation (stimulated glucose level 22% lower) and iron deficiency anemia (hemoglobin: 13.9 vs 12.5 g/dl; iron: 18.4 vs 10.2 $\mu\text{mol/l}$) are prevented. In addition, the patients lose less body weight (8% higher) and they tend to have a better quality of life (life quality score: 84 vs 76 points). Nevertheless, in several studies the number of patients is too small to demonstrate significant differences. *Conclusions:* After total gastrectomy, curatively operated patients might benefit from a reconstruction with pouch and maintenance of duodenal passage. Nevertheless, the present study results are partially divergent. For definitive demonstration of the superiority of this technique, further controlled longitudinal studies should be conducted with a larger number of cases and suitable instruments for assessing the quality of life.

Key words Gastric carcinoma · Total gastrectomy · Duodenal passage · Pouch reconstruction · Quality of life

Introduction

The question of optimal reconstruction after gastrectomy continues to be subject to controversy [1–7]. It is of increasing importance in patients with early stage tumors and favorable long-term prognosis against the background of decreasing morbidity and surgical lethality after gastrectomy [8]. More than 60 different methods of reconstruction have been described. The Roux-en-Y reconstruction is still used most often in Europe [9]. In general, the broad spectrum of reconstruction methods can be subdivided into reconstructions excluding the duodenal passage (DP) with and without a pouch, and reconstructions with restoration of DP with and without a pouch (Fig. 1). In historical terms, reconstructions without DP go back to Schlatter's first gastrectomy in 1887 and the stomach operation propagated by Roux in 1907. A pouch reconstruction was first described by Hoffmann in 1922 and was further developed



RY
in high-risk
patients

HLR
in palliatively
operated patients

JIPP
in curatively
operated patients

Fig. 1 Three different principles of reconstruction in gastrectomy for gastric cancer. RY, Roux-en-Y; HLR, Hunt-Lawrence-Rodino; JIPP, jejunum interposition with pouch

Table 1 Clinical relevance for pouch reconstruction in gastrectomy for gastric cancer: analysis of prospective randomized clinical studies

	Troidl [2]	Schmitz [3]	Nakane [5]	Schwarz [1]	Liedman [6]	Bozetti [7]	Summary [1–3, 5–7]
Year	1987	1994	1995	1996	1996	1996	
Patients	n=38	n=39	n=30	n=60	n=77	n=48	n=292
Type of reconstruction	HLR vs EJ	JIPP vs JIP	(JIPP vs) HLR vs YR	(JIPP vs) HLR vs RY	RY with S-Pouch vs RY	HLR vs RY	
Follow-up	12 months	6 months	24 months	6 months	12 months	24 months	
Reservoir function	Better	Better	Better	–	n.s.	–	Better food intake, less fullness
Emptying/Transit	–	Less vomiting	Better	–	–	Slower transit	Less vomiting slower transit
Reflux problems	–	Less reflux esophagitis	Less heartburn	–	–	Less trouble	Less heartburn, less reflux esophagitis
Body weight (BW)	Better	n.s.	Better	n.s.	Better	–	Less weight loss
Life quality (LQ)	Better score survival >1 year	n.s.	–	n.s.	–	Better	LQ tends to be better, but n.s.
Criticism	Small number of patients; EJ abandoned	Small number of patients; Spitzer not suited	Small number of patients; no LQ data	Short follow-up	Function tests in only 12 patients; S-pouch rarely used	Small number of patients in the follow-up	
Summary	Pouch advantageous with survival >1 year	Pouch shows advantages (n.s.)	Pouch advantageous (HLR in comparison to RY)	Pouch tends to be better (n.s.)	n.s., but less weight loss in patients with pouch	Pouch shows advantage: slower emptying, less complications	Some advantages of pouch. Definitive clarification requires further studies with larger number of patients, longer follow-up, and suitable instruments for measuring LQ

HLR, Hunt-Lawrence-Rodino; EJ, esophago-jejunostomy; JIP, jejunum interposition; JIPP, jejunum interposition with pouch; RY, Roux-en-Y; LQ, life quality; BW, body weight; n.s. not significant

by Hunt in 1952, Rodino in 1956 and Lawrence in 1962 [10–12]. Reconstructions with jejunal interposition and maintenance of DP were described for the first time by Seo in 1942 and further developed by Longmire [13] and Gütgemann [14]. Choosing the individually suited best reconstruction from the large number of possible techniques is made more difficult by the small number of prospectively randomized studies (Tables 1 and 2) and by the problem of establishing objective parameters on the effectiveness of the different procedures. Up to now, there have been seven controlled, prospectively randomized clinical studies dealing with the various methods of reconstruction after gastrectomy [1–7]. These will be discussed below.

The postgastrectomy syndrome

The incidence of “postgastrectomy syndrome” [8, 15–22] depends on the type of reconstruction. Former retrospective studies describe early and late dumping syndrome, on average, in 23.1% (range: 0–60%) of cases after Roux-en-Y reconstruction in contrast to 8.1% (range: 0–33.3%) of cases after jejunum interposition [15]. Alkaline reflux with

esophagitis was described in 30–75% of cases after Roux-en-Y reconstruction in contrast to 8–25% of cases after jejunum interposition and 10% of cases after Hunt-Lawrence-Rodino pouch reconstruction [15, 16, 23]. Dysphagia was seen in 17–40% [8, 17, 18], vomiting in 10–45% [17, 19], lack of appetite in 9–47% [16, 17, 19, 20], underweight and defective nutrition in 37–90% [18, 19, 20], and diarrhea in 4–36% of cases [17, 19, 21, 22].

There are several reasons why postgastrectomy syndrome appears. Removal of the stomach leads to the loss of a food reservoir which is able to release the predigested chymus in a coordinated way. In addition, there is loss of acidification, gastric hormone and enzyme production, and the formation of intrinsic factor. Elimination of the antral pacemaker, the obligatory truncal vagotomy, the possible removal of the celiac plexus in lymphadenectomy and the loss of the lower esophageal sphincter and the pylorus all effect motility. The resulting alkaline reflux frequently leads to severe reflux esophagitis with retrosternal heartburn, belching, vomiting and dysphagia.

These sequelae can be influenced by methods of pouch reconstruction and restoration of duodenal passage. In the present paper, we analyzed the data of all available controlled clinical and animal experimental studies with re-

Table 2 Clinical relevance of duodenal passage in gastrectomy for gastric cancer: analysis of prospective randomized clinical studies

	Fuchs [4]	Nakane [5]	Schwarz [1]	Summary [1, 4, 5]
Year	1995	1995	1996	
Patients	106	30	<i>n</i> =60	<i>n</i> =196
Type of reconstruction	JIPP vs HLR	JIPP vs HLR (vs RY)	JIPP vs HLR (vs RY)	
Follow-up	36 months	24 months	6 months	
Reservoir function	n.s.	Less fullness	–	n.s.
Emptying/intestinal transit	Dumping: n.s.	Less dumping slower transit	–	n.s.
Reflux problems	Reflux esophagitis: n.s.	Heartburn: 0 vs 0%	–	n.s.
Secretion of GI-hormones	–	–	GIP: increased insulin: increased	GIP increased (<i>P</i> <0.01) insulin increased (<i>P</i> <0.01)
Carbohydrate metabolism	–	–	Prevention of a pathological glucose tolerance	Maintenance of DP prevents disturbance of glucose metabolism
Iron and hemoglobin (Hb)	–	–	Iron increased Hb increased	Iron: increased (<i>P</i> <0.01) Hb: increased (<i>P</i> <0.05)
Body weight (BW)	n.s.	Decreased	Higher (<i>P</i> <0.01)	Higher BW
Life quality (LQ)	n.s. (Spitzer, Visick)	–	Better (<i>P</i> <0.01)	Better LQ (<i>P</i> <0.01)
Criticism	Measurement of LQ with instruments not suited for	No data on LQ; number of patients too small in the follow-up	Short follow-up	
Summary	DP shows no advantage	DP shows no advantage	Significant advantage in DP with regard to LQ, BW, iron, Hb and glucose metabolism	Some advantages in DP. Definitive clarification requires further studies: larger number of patients longer follow-up suitable instruments for measuring LQ

HLR, Hunt-Lawrence-Rodino; EJ, esophago-jejunostomy; JIP, jejunum interposition; JIPP, jejunum interposition with pouch; RY, Roux-en-Y; LQ, life quality; BW, body weight; n.s. not significant; GI, gastrointestinal; GIP, gastric inhibitory polypeptide

gard to the relevance and the influence of the reconstruction method on the postgastrectomy syndrome.

Processes of histomorphological and microbiological adaptation

The morphological and functional adaptation of the jejunal pouch have in the meantime been investigated quite well in animal experiments and clinically [1, 3, 5, 23–30]. The pouch volume increases substantially after the operation and reaches about 200% of its initial volume after 6 months [28]. Animal experiments show a change in the morphological structure with muscular wall hypertrophy (100–150%), plump deformation (25–40%) and widening of the villi (25–50%), and reduction of the mucosal surface [26]. Besides the processes of histomorphological adaptation, there are also changes in the microbial population. Physiologically, the chymus is largely decontaminated initially by the low gastric pH resulting from gastric acid production [31]. The small intestinal flora is primarily regulated by the stomach acid and the motility of the small intestine [32]. In the investigations of Bradley [33]

and Armbrecht [34], colonization of the small intestine was thus inevitable in Roux-en-Y reconstruction. Up to now, there have been no comparative investigations between jejunal interposition and Roux-en-Y reconstruction with respect to their effect on colonization of the small intestine with microorganisms.

Influence of reconstruction on motility

Reservoir function, emptying and intestinal transit, problem of reflux

After gastrectomy, we expect that creating a jejunal pouch will enable intake of larger portions of food, will provide a barrier against intestino-esophageal reflux (and thus less reflux esophagitis), will delay the passage time, cause fewer dumping symptoms, and will enable a better utilization of the food ingested.

In order to fulfill these functions, processes of adaptation in the pouch are necessary. These take 3–6 months. In this time, there is a change in the motility pattern with a reduction of the propagation velocity from 3.7 ± 0.2 cm/min

to 2.7 ± 0.1 cm/min after 3 months and the motility index was reduced from 43.2 ± 7.1 to 35.7 ± 6.8 at 3 months post-operatively [25, 27]. Sequenced scintigraphic investigations reveal that the pouch reconstruction is a good barrier against intestino-esophageal reflux [5, 30]. This is reflected clinically in less frequent heartburn (4% vs 20%) and a lower rate of reflux esophagitis (10% vs 60%) [23]. In addition, sequenced scintigraphic emptying studies show that the ingested food circles for a long time in the pouch and that the pouch is hence a good reservoir. After 20 min, about 50%, and after 45 min, about 30% of the applied quantity of a technetium-labeled testmeal still can be detected in the region of the pouch in contrast to 30% after 20 min and 10% after 45 min in Roux-en-Y patients [23]. Clinically, this is manifested in rarer dumping symptoms (3% vs 37%) [23].

In a prospectively randomized study, Nakane [5] compared the following reconstructions: Roux-en-Y versus Rodino versus jejunum interposition with pouch (Table 1). In this study, patients with Rodino reconstruction show a significantly greater food intake and a significantly better weight development. Scintigraphic tests to measure reservoir and emptying function show the poorest results for the Roux-en-Y group 1 year after gastrectomy. At 20 min after the ingestion of a technetium-labeled semisolid testmeal, the counted radioactivity in the pouch interposition group was 52%, in the Rodino pouch group, 40%, and in the Roux-en-Y group, 0% of the ingested activity.

To investigate the question of the ideal pouch volume, Tanaka [30] carried out scintigraphic measurements of reflux and emptying rate in reconstructions with different pouch sizes (15 cm and 20 cm). The short pouch showed advantages since it had fewer reflux phases (reflux index 7.05 ± 3.35 vs 9.57 ± 5.52) compared to the long pouch and the emptying rate, $t_{75\%}$, was significantly shorter ($P < 0.05$) in the short pouch group than in the long pouch group (21.1 ± 15.39 min vs 46.0 ± 16.2 min). In the randomized Ulm study [1], pouch reconstructions with various volumes were also compared. Reconstruction with a small 10 cm pouch tended to manifest advantages with regard to quality of life and body weight development compared to the 20 cm-long pouch.

Altogether, pronounced advantages with regard to motility for patients with pouch reconstruction are shown by the analysis of prospectively randomized clinical studies (Table 1). Pouch reconstruction promises better food intake [2, 5], less feeling of fullness [3, 5] and less vomiting [3]. Scintigraphy reveals good retention with slower emptying [5, 7]. Less heartburn [3, 5, 7] is found clinically, and reflux esophagitis is revealed more rarely by endoscopy [3]. With maintained duodenal passage (Table 2), the studies available [1, 4, 5] do not show any significant advantages with regard to reservoir function, emptying and the problem of reflux.

Influence of reconstruction on resorption capacity and metabolic regulation

Change in the secretion of gastrointestinal hormones

Direct contact of the chymus with the duodenal mucosa is a secretory stimulus for the peptide hormone-producing cells located in the duodenal mucosa. Elimination of the duodenal passage hence has a major effect on the secretion of gastrointestinal hormones and thus on the function of the gastrointestinal tract. This was investigated in greatest detail in the Ulm study [1]. Maintenance of DP leads to intensified insulin secretion with a peak concentration of $158 \mu\text{U/ml}$ in the pouch interposition group in comparison to $22 \mu\text{U/ml}$ in the Rodino group and $33 \mu\text{U/ml}$ in the Roux-en-Y group ($P < 0.01$) [1]. Insulin release is stimulated inter alia by the gastrointestinal hormones CCK and GIP [1, 35, 36], which are released by direct contact of the food with the duodenal mucosa. Reconstruction with and without maintenance of DP leads to a different pattern for the distribution of peptide-hormone producing cells in the pouch [29]. This has a relevant effect on the regulation of gastrointestinal hormones and the resorption capacity [1]. Pouch reconstruction and pouch volume do not have a significant effect on the secretion of gastrointestinal hormones. On the other hand, maintenance of duodenal passage leads to a significant increase of the secretion of insulin (158 vs $22 \mu\text{U/ml}$; $P < 0.01$) and GIP (5292 vs 3938 pg/ml; $P < 0.01$), which has a beneficial effect on blood sugar regulation. In addition, there is a more physiological secretion of pancreatic polypeptides in maintained DP [1, 36].

Carbohydrate metabolism

Regulation of blood sugar is disturbed after gastrectomy in which the DP has been eliminated. A pathological glucose tolerance results, which can be avoided by maintaining DP [37, 38]. In the Rodino group, the stimulated maximal glucose values on average are 30% above normal, and the blood glucose levels increase statistically and significantly faster ($P < 0.01$) than in the pouch interposition group [1]. However, by itself the pouch and the pouch volume do not have a significant effect on carbohydrate metabolism [1].

Lipid metabolism

After gastrectomy, increased steatorrhea is observed when DP is not preserved. This may be explained by poorer mixing of the chymus with bile salts and pancreatic enzymes. Bradley [39] found fat losses amounting to 17% of the amount of fat ingested, corresponding to a caloric loss of up to 500 kcal/day.

Resorption of iron and its importance for the hemoglobin values

The serum iron level depends on maintenance of DP owing to resorption in the duodenum and proximal jejunum. After gastrectomy without maintenance of DP, it falls substantially (10.2 ± 1.34 vs 18.4 ± 1.36 $\mu\text{mol/l}$) and is 45% less ($P < 0.01$) than in reconstruction with maintenance of DP [1]. Iron deficiency anemia can therefore be prevented by maintenance of DP. The hemoglobin levels (13.9 ± 1.27 vs 12.5 ± 1.28 g/dl) are significantly higher ($P < 0.05$) in maintained DP [1]. On the other hand, pouch reconstruction and pouch volume do not have a significant effect on iron resorption and hemoglobin values [1, 3].

Development of body weight in relation to reconstruction

After gastrectomy, there are losses of weight of 15%–20% [40]. However, these are very much less with maintenance of DP. In the randomized Ulm study [1], patients with jejunal interposition and pouch reconstruction show a significant rise of the body weight 6 months after the operation ($P < 0.01$). It is 7.8% in excess of the weight in patients without maintenance of DP [1]. It is not only DP but also the pouch reconstruction which is responsible for this. In three other studies to investigate the significance of pouch reconstruction, lower losses of body weight are also found in the course after pouch reconstruction [2, 5, 6].

Influence of the type of reconstruction on the quality of life

The clinical studies carried out up to now differ with regard to the appraisal of the quality of life. The main problem in appraising the quality of life after gastrectomy is to choose an appropriate instrument for measuring this composite parameter as objectively as possible. Very fine differences in subjective well-being must be detected as precisely as possible, which is not feasible with conventional methods such as the Spitzer index [41] and the Visick score [42]. Clinical studies to measure the subjective well-being of the patient after gastrectomy must be oriented in the future to specific well-validated instruments for measuring the quality of life [43, 44].

Clinical advantages of pouch reconstruction compared to Roux-en-Y reconstruction have been described several times. However, none of the prospectively randomized studies carried out up to now (Table 1) were able to show a statistically significant functional superiority [1–3, 5–7]. Troidl [2] compared two reconstruction types without maintenance of DP in a prospectively randomized study: Rodino pouch versus esophago-jejunostomy without pouch. At 6 months postoperatively, the total life quality score (the disease specific score, respectively) in the Ro-

dino pouch group ranged from 7.5 to 13 (3.5–8) in comparison to 2–10 points (2–5.5) after esophago-jejunostomy. Patients in the Rodino pouch group had an advantage with regard to the quality of life when they survived longer than 1 year.

Schmitz [3] compared two groups with maintained DP in a prospectively randomized study. The interposition was made with and without pouch reconstruction. For the pouch group, there tended to be an advantage 6 months after the operation with regard to the quality of life, but the difference was not statistically significant because the number of cases was relatively small overall. The quality of life was registered in this study with the relatively nonspecific Spitzer index [41] and the more specific, but not sufficiently validated, test according to Cuschieri [45].

Fuchs [4] did not find any significant differences in the quality of life in a prospectively randomized study between the two groups, jejunal interposition with pouch versus Rodino substitute stomach (Table 2). However, the quality of life was registered with relatively nonspecific tests (Visick score [42] and Spitzer index [41]). In the randomized Ulm study [1], three different reconstructions (jejunal interposition with pouch of 10 resp. 20 cm versus Rodino pouch of 10 resp. 20 cm versus Roux-en-Y) were compared. Quality of life was measured with a well-validated, highly specific gastrointestinal quality of life index. At 6 months after gastrectomy, the mean life quality score achieved 69 ± 3.24 points in the Roux-en-Y group, 76 ± 3.05 points in the Rodino group, and 84 ± 2.06 points in the pouch interposition group, which is statistically and significantly higher ($P < 0.01$). The pouch volume did not have a significant influence on the quality of life score. These life quality data demonstrate that there is no significant difference between reconstruction with and without pouch, but there is a statistically significant difference between reconstruction with and without preservation of the DP [1].

To summarize, a trend to a better quality of life was seen in the studies on the relevance of pouch reconstruction [1–3, 5–7] (Table 1). However, the differences registered are not statistically significant. This is due to the small number of cases or in some cases to the choice of unsuitable instruments for measuring the quality of life. The quality of life is also favorably affected in the course by the maintenance of DP. The Ulm study finds significant advantages in this regard [1]. However, these advantages are manifested after 6 months at the earliest. For this reason, only patients with a greater life expectancy benefit from elaborate methods of pouch reconstruction.

Conclusion

Curatively operated patients with a good long-term prognosis might benefit from a pouch reconstruction with maintenance of DP (Fig. 1). However, the clinical advantage is manifested after 6 months at the earliest. If a palliative R1 or R2 resection is the only possibility, Rodino reconstruction can be performed, since these patients do not benefit

from pouch interposition due to their restricted life expectancy. The Roux-en-Y reconstruction without pouch has the advantage of the shortest duration of operation and should be confined to high-risk patients. In addition, Roux-en-Y reconstruction can be proposed for technical reasons in carcinoma of the cardia with intrathoracic anastomosis. However, definitive clarification of the value of pouch reconstruction in maintained DP requires further randomized longitudinal clinical studies with a larger number of patients and suitable instruments for measuring the quality of life.

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