

## Nutritional Effects according to Reconstructional Methods after Total Gastrectomy

Jin Sik Min, Seung Ho Choi, Sung Hoon Noh and Myung Wook Kim<sup>1</sup>

*Malnutrition and weight loss after total gastrectomy is one of the major concerns of surgeons. In order to improve the nutritional status in these patients, many surgeons have tried to restore the duodenal passage as reconstructive procedure but debates have been continued. So we investigated weight change, postprandial serum secretin response and fecal fat amount to evaluate the esophagojejunoduodenostomy after which the duodenal passage was restored. Total gastrectomized dogs showed significant weight loss and all experimental animals except sham operation died between five and eight weeks after the operation. Serum secretin concentration after esophagojejunoduodenostomy increased significantly from a mean fasting value of  $100 \pm 12.5$  pg/mL to a mean peak of  $142 \pm 22.5$  pg/mL at 40 minutes and returned to the fasting level at 120 minutes postprandially. But fasting and postprandial serum secretin concentration in patients following Roux-en Y esophagojejunostomy were fluctuated irregularly. The amount of fecal fat in esophagojejunoduodenostomy was  $5.3 \pm 1.2$  gm/100 gm stool, which was not different from that of the control group but in Roux-en Y esophagojejunostomy it was  $28.1 \pm 4.1$  gm/100 gm stool which was much higher than that observed in esophagojejunoduodenostomy and in control group. These results suggest that esophagojejunoduodenostomy is superior to Roux-en Y esophagojejunostomy in respect to pancreatic secretory function and fat absorption.*

**Key Word:** Nutrition-Reconstruction-Total gastrectomy

Gastric resection in patients with gastric cancer has been increased due to early detection and development of aggressive surgical methods. As a result, long-term survivors after total gastrectomy for curative gastric resection have been also increased(Choi *et al.* 1991). However total gastrectomy causes severe nutritional problems due to a loss of gas-

tric function including gastroesophageal sphincter(Cuschieri 1989). Defunctionalized Roux-en Y limb which is performed about 40-45 cm distal to the esophageal anastomosis can prevent the bile reflux esophagitis(Scott *et al.* 1956). Nevertheless, most of the reconstructive procedures after gastric resections are duodenal bypasses which cause malnutrition in patients because of inappropriate hormonal response to the ingested food and its inadequate mixing with the biliopancreatic secretions(Garofalo *et al.* 1985, Poth *et al.* 1966).

In this study, we investigated the weight changes, concentration of serum secretin and fecal content of fat, and also analysed the effect of the duodenal passage reconstruction on nutrition, after gastric resection in animal study.

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**MATERIALS AND METHODS**

Fifteen dogs weighing 14Kg to 16Kg were supplied from animal laboratory in Yonsei medical center. They were raised for 1 week for adaptation to the environments and foods. All dogs were on NPO status for about 18 hours prior to the operation and with Seconal 750 mg i.v. the general anesthesia was performed followed by endotracheal intubation. We divided the dogs into three groups, each group with 5 dogs. Group I was the control which had exploratory laparotomy performed only. In group II esophagojejunoduodenostomy (EJD) was performed after total gastrectomy and in Group III Roux-en Y esophagojejunostomy (Roux-en Y) was done. EJD consisted of an end-to-side anastomosis between the esophagus and the transposed jejunal loop, and end-to-end anastomosis between the proximal end of the inverted long jejunal limb and the duodenum. The side-to-side anastomosis between the proximal jejunal limb and the distal limb was performed. The procedure was completed by an enteroenteral end-to-side anastomosis (Fig. 1). Roux-en Y esophagojejunostomy is the

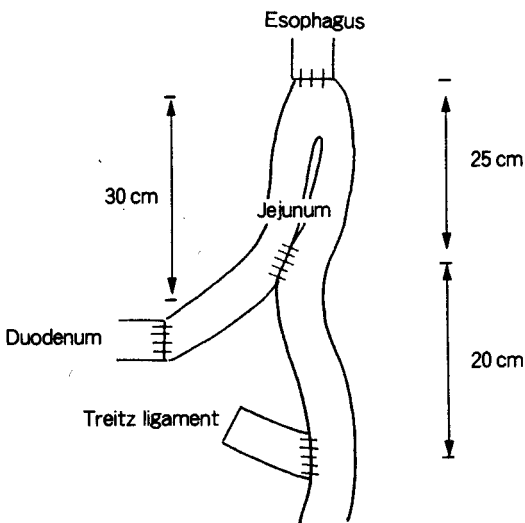
procedure which have a long jejunal limb about 40cm in length and end-to-side anastomosis between the esophagus and the end of jejunal limb and completed by enteroenteric anastomosis (Fig. 2).

From the postoperative day 3, nutrient about 100 Cal/Kg (protein 20%, fat 15%, carbohydrate 65%) was supplied, and then both weight changes and serum secretin levels were checked daily.

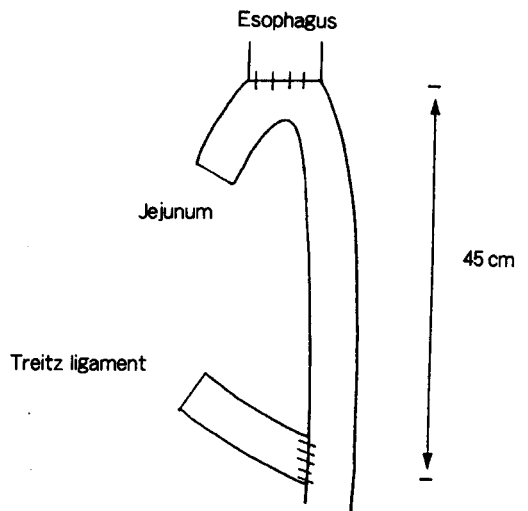
The blood was drawn before the feeding, and 5 consecutive times with 20 minutes intervals postprandially, 1 month after the operation.

Five mL blood sampled in ice-cold, heparinized plastic tube, was centrifuged immediately for 10 minutes at 3,000 rpm. And the serum was stored at -20°C. The level of serum secretin was checked using radioimmunoassay (Daiichi Radioisotope Labs., Ltd., Japan).

Two hundred  $\mu$ L serum sample with 1 mL rabbit's antiserum to synthetic porcine secretin was incubated for 4 days in 4°C. And then 125-I-secretin 100 uL was added and incubated for 1 day at 4°C. Anti-rabbit gamma globulin Goat serum 100 uL was added. After centrifuged at 2,000 rpm for 30 minutes, supernatants were discarded and the radioactivity of the precipitate was measured(B). The same



**Fig. 1.** Esophagojejunoduodenostomy.



**Fig. 2.** Roux-en Y esophagojejunostomy.

procedure was performed except the control serum which was zero in secretin (B0) and the ratio between B and B0 was calculated.

$$B/B_0 = \frac{\text{count rate of sample}}{\text{mean count rate of zero standard}}$$

After that, the standard curve was made and the secretin concentration from the standard curve was evaluated.

### Fecal fat content

The fat amount of feces was checked quantitatively by Van de Karger method after collecting feces for 3 days at 6th week post-operatively (Wagner 1967).

$$\text{Fat (gm)/100 gm stool} = \frac{n \times 284 \times 1.04 \times 2 \times 100}{10,000 \times w}$$

n: mL of 0.1 N Sodium hydroxide titration  
w: weight of stool taken

### Scintiscan

Six months later, Gamma camera images of the upper abdomen were obtained in Group II (EJD) after ingestion of milk 50 mL with Tc99m 3mCi while dogs were under general anesthesia.

### Statistics

The statistical analysis was performed on the basis of the regression analysis and wilcoxon ran sum test.

## RESULTS

### Weight change

The weight reduction in experimental Group II and III were significant. But control group was not (Fig. 3). All experimental animals died between fifth and eighth week after operation except sham operation. The difference of weight change between Group II and Group III was not significant ( $p > .05$ ).

### Serum secretin

Serum secretin concentration after esophagojejunoduodenostomy increased significantly

from a mean fasting value of  $100 \pm 12.5$  pg/mL to a mean peak of  $142 \pm 22.5$  pg/mL at 40 minutes and returned to fasting level at 120 minutes after meal. But fasting and postprandial serum secretin concentration in patients following Roux-en Y esophagojejunostomy were fluctuated irregularly (Fig. 4).

### Fecal fat content

The amount of fecal fat in esophagoje-

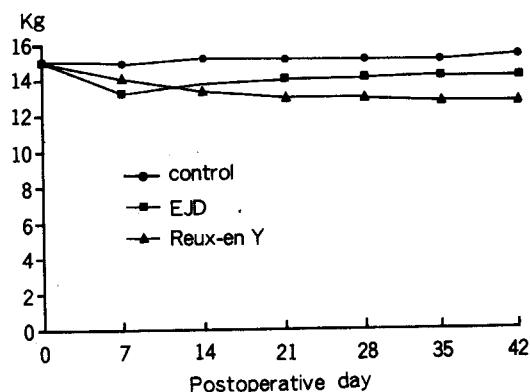


Fig. 3. Body weight changes after esophagojejunoduodenostomy or Roux-en Y esophagojejunostomy. EJD: esophagojejunoduodenostomy Roux-en Y: Roux-en Y esophagojejunostomy

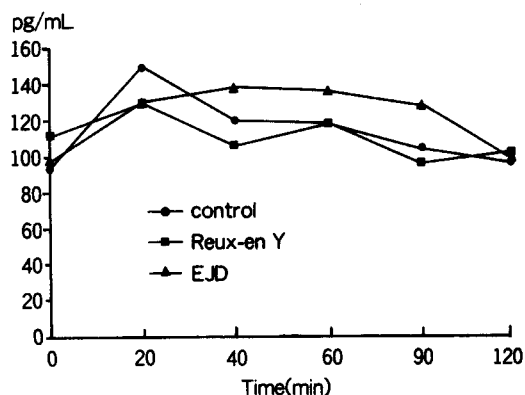


Fig. 4. Serum secretin concentration in esophagojejunoduodenostomy and Roux-en Y esophagojejunostomy before and after meal. EJD: esophagojejunoduodenostomy Roux-en Y: Roux-en Y esophagojejunostomy

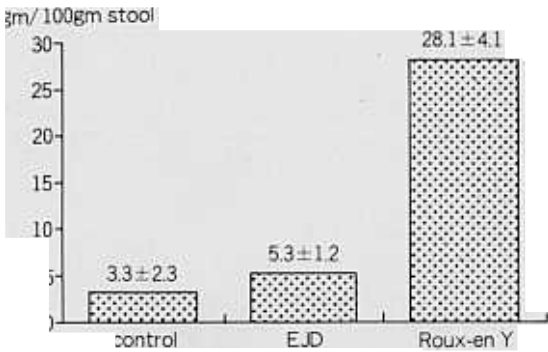
junoduodenostomy was  $5.3 \pm 1.2$  gm/100 gm stool, which was not different from that of control group but in Roux-en Y esophagojejunostomy it was  $28.1 \pm 4.1$  gm/100 gm stool which was much higher than that observed in esophagojejunoduodenostomy and in control group (Fig. 5)( $p < .05$ ).

**Scintiscan**

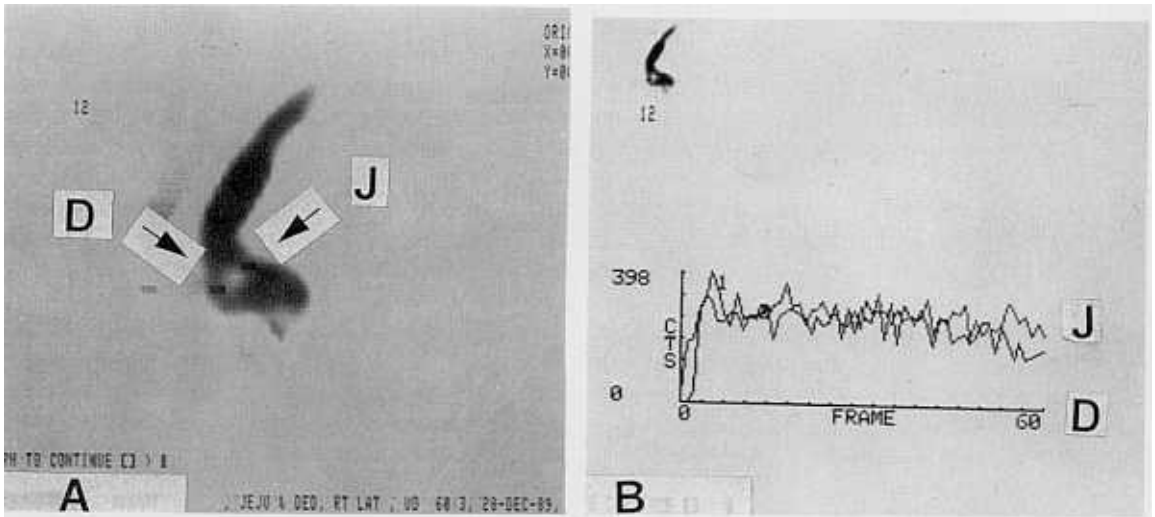
The radioactivity between duodenum and jejunum after ingestion of Tc99m was similar in EJD group (Fig. 6).

**DISCUSSION**

Although significant weight loss has been regarded as a necessary consequence of the total gastrectomy, the exact causes of malnutrition have been controversial. Some have felt that postoperative malnutrition after total gastrectomy was attributable to malabsorption due to bacterial overgrowth, mucosal lesions of the small intestine, relative pancreatic enzyme insufficiency and shortened small intestinal transit time (Lundh 1958, Adam 1968). While others have suggested that the major cause of malnutrition was inadequate caloric intake because of absence of hunger, dyspepsia, alteration of the intestinal motility, and early satiety (Bradley *et al.* 1975, Braga *et al.* 1988). A number of attempts for reestablishing continuity after total gastrectomy have been



**Fig. 5.** The amount of fecal fat in esophagojejunoduodenostomy and Roux-en Y esophagojejunostomy after meal.  
 EJD: esophagojejunoduodenostomy  
 Roux-en Y: Roux-en Y esophagojejunostomy



**Fig. 6.** Scintigraphic image of duodenum and jejunum after ingestion of Tc99m-labeled milk(left). It showed duodenal and jejunal passage of meal. Radioactivity within the duodenum and jejunum (black rectangle) is quantitated on serial image(right).

undertaken for many years with the aim of improving comfortable eating and good nutrition.

Malabsorptions following duodenal bypass procedures, compared to the reconstructions which reestablish duodenal circuit, have been attributed to the exclusion of the duodenum and the development of a blind loop with bacterial overgrowth, which resulted in the unbalance and the co-ordination of the hormonal response to ingested food and inadequate mixing of the chyme with the bile and pancreatic juice (Cuschieri 1982, Henly 1953, Poth 1966). However there are few well controlled comparative studies about the nutritional facts in duodenal bypass procedures and those retaining duodenal continuity.

We observed that in patients who had total gastrectomy, the weight gain started sixth months after total gastrectomy (Choi *et al.* 1991). In this study, sham operation showed no weight change, but experimental groups irrespective of duodenal bypass showed weight loss significantly after total gastrectomy. Unfortunately, we couldn't observe longterm body weight pattern due to death during fifth and eighth postoperative week.

The pancreatic exocrine function is under both hormonal and neural control, with hormonal control being the primary importance. The most two important hormones are secretin and cholecystokinin (CCK).

In addition to gastric acid, long-chain fatty acids and certain essential amino acids such as tryptophan, phenylalanine, valine, and methionine can release CCK from duodenum and jejunum. Especially, in absence of gastric acid the duodenal passage of food is very important in the release of CCK (Wagner 1967). The secretin stimulates secretion of pancreatic juice rich in water and electrolyte. Mucosal acidification under pH 4.5 increases the release of secretin, and also duodenal passage stimulates the secretion of secretin (Nishiwaki *et al.* 1983). Dr. Garofalo suggested that the mixing with biliopancreatic secretion, even with the deprived gastric function results in significant dilution of bolus and the decrease in the dumping syndrome and malabsorption (Garofalo 1985). Faichney *et al.* and Nishiwaki

*et al.* stressed that bile and fat can stimulate S cell which secretes the secretin and in case of total gastrectomy this stimulus via duodenal passage is very important (Faichney *et al.* 1981, Nishiwaki *et al.* 1982). Also we observed that Roux-en Y esophagojejunostomy which is duodenal bypass procedure showed irregular pattern of serum secretin level, but EJD showed a mean fasting value of  $100 \pm 12.5$  pg/mL and a mean peak of  $142 \pm 22.5$  pg/mL at 40 minutes with returning to fasting level at 120 minutes. The findings in EJD are similar to sham operation after food ingestion.

The most of the patients who received total gastrectomy showed postprandial hyperglycemia (Harju *et al.* 1985). Camfield *et al.* and Sudo *et al.* stressed that glucose intolerance after total gastrectomy was attributed to vagotomy, and it did not need insulin therapy (Camfield *et al.* 1983, Sudo *et al.* 1982). Sakakibara showed that the postoperative carbohydrate absorption rate through the digestive system was high whether the duodenum was bypassed or not, but there was a significant difference between the two groups in the rates of absorption of proteins and fats. In those that reestablished duodenal circuit absorption rates of proteins and fats were 85% and 93% respectively. On the other hand, that of proteins and fats in the duodenal bypass procedure were slightly lower as each respectively 80% and 78% (Sakakibara *et al.* 1989). This suggested that whether the food passes through the duodenum or not is significantly important to the rate of absorption, especially for fat absorption. In this study, fecal fat content in EJD were not different from that of sham control group, however those in Roux-en Y than in EJD and control were significantly decreased.

Antiperistaltic segment of jejunum between esophagus and duodenum may provoke the reflux but side-to-side jejunal anastomosis could prevent it. In this EJD, there are two circuits which might cause the blind loop syndrome. However, we could not find any deteriorating effect due to blind loop (Choi *et al.* 1991).

Even though Troidle stressed that duodenal passage of food did not influence nutrient absorption in prospective controlled study,

many surgeons think that the duodenal passage is very important to improve the nutritional status in patients after total gastrectomy (Cuschieri 1982, Henly 1953, Poth 1966). We have failed to demonstrate a long term pattern of weight change according to the reconstructive types, however, our results suggested that duodenal passage of meal improved the pancreatic secretory function and fat absorption, in dogs.

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