

Original

Assessment of Perioperative Nutritional Management after Total Gastrectomy: Comparison between Total Parenteral Nutrition and Peripheral Parenteral Nutrition

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Background: Perioperative nutritional management after total gastrectomy was comparatively assessed between patients receiving total parenteral nutrition (TPN) and peripheral parenteral nutrition (PPN). **Methods:** The subjects of the study were 41 patients of TPN group and 41 patients of PPN group. The changes in the nutritional status between before and after surgery and the frequencies of infectious complications were comparatively assessed between the two groups. **Results:** In regard to the changes in the nutritional status, the serum Alb level was significantly higher in the PPN group than in the TPN group on postoperative day 14. The peripheral blood lymphocyte count was significantly higher in the TPN group than in the PPN group on postoperative day 14. In regard to infectious complications, the serum C-reactive protein was significantly higher in the TPN group on postoperative day 3. The plasma glucose level was significantly higher in the TPN group on postoperative days 3 and 7. The number of patients with pyrexia and the frequency of infections of diagnosed cause tended to be higher in the TPN group, however, the differences were not significant. **Conclusions:** The results of the present assessment indicate no merits of TPN over PPN after total gastrectomy.

Key words: gastrectomy, perioperative procedures, parenteral nutrition, total

Introduction

In recent years, there has been much debate about the most suitable method for nutritional management after gastroenterological surgery.

The frequencies of complications after gastroenterological surgery are believed to have decreased with the introduction of total parenteral nutrition (TPN). Even after total gastrectomy, many institutions at present adopt TPN for postoperative nutritional management. On the other hand, the frequency of complications related to TPN is also too high to ignore. According to the guidelines established by the Japanese Society for Parenteral Enteral Nutrition (in 2006), "Routine implementation of central venous nutrition should be avoided in the patients undergoing gastroenterological surgery. In patients having difficulties with early oral intake or

enteral nutrition, however, central venous nutrition must be adopted, after adequately considering the potential metabolic and infectious complications".

In recent years, anastomoses of the gut have become safer and the postoperative fasting periods have also tended to become shorter, owing to advances in the anastomotic techniques and devices. There are also some institutions where a clinical pathway similar to that following gastrectomy is used for postoperative management¹⁾. When the daily caloric requirement in nutritional management after total gastrectomy is taken into consideration, is TPN a theoretically essential method in actual clinical settings? At our department as well, we previously inserted a central venous catheter (CV catheter) preoperatively for TPN in patients after total gastrectomy. In December 2003, however,

Table 1 Composition of infusion

	TPN group	PPN group	
Volume of infusion (ml)	2,071 ± 136	2,045 ± 141	N.S
Calories (kcal/day)	1,246 ± 189	449 ± 158	p<0.001
Glucose (g/day)	269 ± 409	102 ± 34	p<0.001
Amino acids (g/day)	42.8 ± 7.9	11.1 ± 8.5	p<0.001
Na (Meq/day)	107.0 ± 13.1	132.6 ± 37.3	p<0.001
K (Meq/day)	51.7 ± 6.9	30.7 ± 6.4	p<0.001
Cl (Meq/day)	103.3 ± 10.9	119.6 ± 29.4	p=0.004

TPN: total parenteral nutrition, PPN: peripheral parenteral nutrition.

we began to adopt peripheral parenteral nutrition (PPN) for nutritional management in patients undergoing total gastrectomy, taking into consideration the rather high incidence of complications of CV catheterization.

We conducted a retrospective study wherein patients undergoing total gastrectomy were divided, based on the postoperative nutritional management method adopted, into TPN group or PPN group, and the two groups were comparatively evaluated.

Subjects and Methods

The PPN group, in which PPN was adopted for postoperative nutritional management, consisted of 41 patients who underwent total gastrectomy (including combined resection of other involved organs and total resection of the residual stomach) for gastric cancer or malignant lymphoma between December 2003 and February 2006. The TPN group, in which parenteral hyperalimentation was adopted for postoperative nutritional management, included another 41 patients previously been managed by TPN and were serially recruited in reverse order from among patients who underwent gastrectomy between June 2000 and November 2003. In the TPN group, a commercially available TPN infusion preparation was used: amount of infusion, 1,387-2,257 (2,071 ± 136) ml/day and calories administered, 904-1,600 (1,246 ± 189) kcal/day. The administration was initiated from postoperative day 1 or 2. In the PPN group, a commercially available infusion preparation was used: amount of infusion, 2,000-2,500 (2,045 ± 141) ml/day and calorie, administered, 172-716 (449 ± 158) kcal/day. The administration was initiated from postoperative day 1. Table 1 shows the amounts of glucose, amino acids and elec-

Table 2 Patient background

	TPN group (n = 41)	PPN group (n = 41)	
Male	26	23	(N.S)
Female	15	18	
Age	64.6 ± 11.3	66.2 ± 11.1	(N.S)
Stage Ia	10	11	
Stage Ib	6	5	
Stage II	7	4	
Stage IIIa	4	7	
Stage IIIb	4	2	
Stage IV	10	11	
Malignant lymphoma	0	1	

TPN: total parenteral nutrition, PPN: peripheral parenteral nutrition.

trolytes (Na, K, Cl) administered. The TPN group was compared with the PPN group in terms of the patient background (sex, age, histological stage of cancer) and perioperative parameters [operative time, volume of blood loss, fasting period, calories administered daily, and the postoperative length (days) of hospitalization]. Changes in the nutritional status and the frequencies/specifics of infectious complications were also compared between the two groups. The results were statistically analyzed by Student's *t*-test and Welch's *t*-test, and *p* values of less than 0.050 were considered to denote significance. The statistical analysis software StatView 5.0 was used for the statistical analyses.

Results

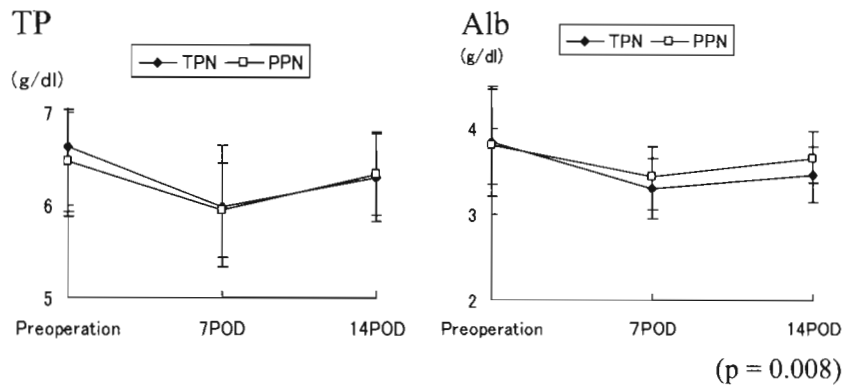
1. Patient background

Table 2 shows the sex distribution, age and histological stage of the cancer in the two groups. There were more male than female patients in both groups, however, there was no significant difference between the two groups in terms of the male-to-female ratio. There was also no difference in the

Table 3 Parameters in the perioperative period

	TPN group	PPN group	
Operative time (min)	260.2 ± 70.0	254.0 ± 65.3	N.S
Volume of blood loss (ml)	704.9 ± 316.0	615.9 ± 303.9	N.S
Fasting period (days)	7.05 ± 1.70	6.25 ± 1.27	p=0.018
Postoperative length of hospitalization (day)	21.75 ± 13.99	20.05 ± 5.74	N.S
Changes in body weight (kg)	- 3.73 ± 2.00	- 3.64 ± 1.84	N.S

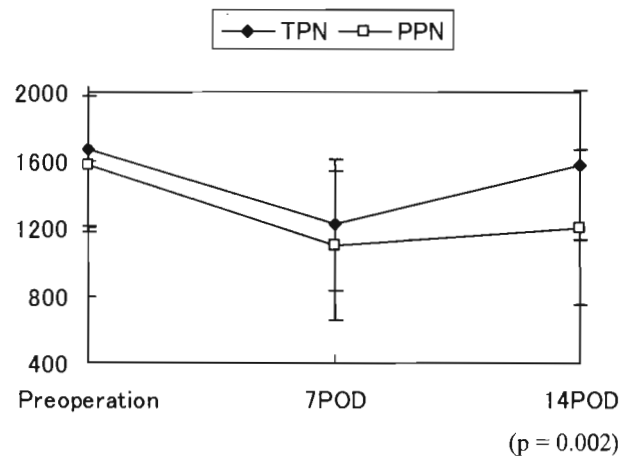
TPN: total parenteral nutrition, PPN: peripheral parenteral nutrition.

**Fig. 1** Changes in the serum protein level (total protein: TP), serum albumin level (Alb)

mean age between the two groups, or any significant difference in the overall distribution of the histological stage of the cancer among the subjects of each group. A comparison of the perioperative parameters is shown in Table 3. There was no significant difference in the operative time or volume of blood loss between the two groups. The mean postoperative fasting period was 7.05 days in the TPN group and 6.25 days in the PPN group, being significantly ($p=0.018$) longer in the TPN group than in the PPN group. The mean postoperative length of hospitalization was 21.8 days in the TPN group and 20.1 days in the PPN group, with no significant difference between the two groups.

2. Nutritional status

Changes in the serum protein level (total protein: TP), serum albumin level (Alb), peripheral blood total lymphocyte count and body weight, which are all indicators of the perioperative nutritional status, were also compared between the TPN group and the PPN group. The serum TP level (Fig. 1) tended to decrease postoperatively in both groups, however, there was no significant difference in the extent of decrease between the two groups. Although there was no significant ($p=0.810$) difference in se-

**Fig. 2** Changes in the Peripheral blood total lymphocyte count

rum Alb level (Fig. 1) preoperatively between the groups, the Alb level in the TPN group was significantly ($p=0.008$) lower than that in the PPN group on postoperative day 14. There was no difference in the peripheral blood total lymphocyte count (Fig. 2) either preoperatively or on postoperative day 7 between the two groups. however, on postoperative day 14, the count was significantly lower in the PPN group ($p=0.002$) than in the TPN group. There was no significant ($p=0.910$) difference between the two groups in terms of the changes of the body weight

Table 4 Patients with pyrexia

	TPN group	PPN group	
Patients with pyrexia ($\geq 38^{\circ}\text{C}$)	20 (48.8%)	15 (38.5%)	$p=0.352$
Pyrexia ($\geq 38^{\circ}\text{C}$) persisting for at least 3 days	6 (14.6%)	3 (7.69%)	$p=0.326$

TPN: total parenteral nutrition, PPN: peripheral parenteral nutrition.

Table 5 Number of patients with postoperative infections

	TPN group n = 8 (19.5%)	PPN group n = 5 (12.8%)
Intraperitoneal abscess	2	
Pneumonia	1	2
Catheter sepsis	2	1
Wound infection	2	1
Cholecystitis	1	1

TPN: total parenteral nutrition, PPN: peripheral parenteral nutrition.

between before and after surgery (Table 2).

3. Infectious complications

The following items were compared to assess the differences in the perioperative infectious complications between the two groups: 1) The frequency of pyrexia of 38°C or higher and of pyrexia lasting for at least 3 days; 2) infectious complications of diagnosed causes; 3) postoperative changes in the peripheral blood white blood cell count (WBC) and serum level of C-reactive protein (CRP); and 4) changes in the blood sugar levels.

1) Postoperative pyrexia of 38°C or higher (Table 4) was recognized in 20 patients (48.8%) of the TPN group and 15 patients (38.5%) of the PPN group, showing a higher frequency in the TPN group, although the difference between the two groups was not statistically significant. Pyrexia lasting for at least 3 days was found in 6 patients (14.6%) of the TPN group and 3 patients (7.7%) of the PPN group; thus, the frequency of persistent pyrexia was also higher in the TPN group, although again, there was no significant difference between the two groups ($p=0.326$). 2) Infectious diseases of diagnosed cause were recognized in 8 patients (19.5%) of the TPN group and 5 patients (12.8%) of the PPN group, as shown in Table 5; the frequency was higher in the TPN group. 3) There was no signifi-

cant difference in the WBC count (Fig. 3) between the two groups either preoperatively or during the postoperative course. The serum CRP level (Fig. 3) was significantly ($p=0.039$) higher in the TPN group than in the PPN group on postoperative day 3, however, there was no difference of the serum CRP level between the two groups at any of the other time-points of measurements. 4) There was no significant difference in the plasma glucose level (Fig. 4) between the two groups either preoperatively or on postoperative day 14, however, the plasma glucose levels on postoperative day 3 and postoperative day 7 were 135.0 ± 23.8 ($p=0.049$) and 139.7 ± 31.0 ($p=0.006$), respectively, in the TPN group, which were significantly higher as compared with the levels at the corresponding time-points in the PPN group.

Discussion

Ever since 1968, when it was reported for the first time²⁾, TPN has been used as a major strategy of perioperative nutritional management in the field of gastroenterological surgery. At our own department as well, we regularly used TPN, at a daily caloric dose of 900-1,600 kcal, for the nutritional management of patients after total gastrectomy, until our attention was drawn to the rather high incidence of complications related to TPN. Fukushima³⁾ reported that the optimum perioperative caloric requirement for moderately invasive surgery (including partial gastrectomy, resection of the large intestine, etc.) is 1.1-1.3 times (25-30 kcal/kg/day) the predicted basal energy expenditure (BEE), and that for total gastrectomy is 1.2-1.4 times (30-35 kcal/kg/day) the BEE. Yoneyama⁴⁾ measured the mean oxygen consumption per minute and the mean amount of carbon dioxide produced per minute by indirect calorimetry in surgically treated patients with gas-

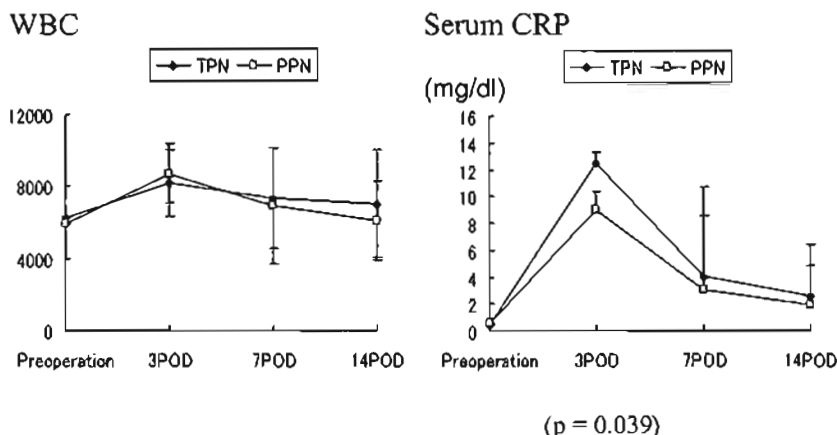


Fig. 3 Changes in the peripheral blood white blood cell count (WBC) and serum level of C-reactive protein (Serum CRP)

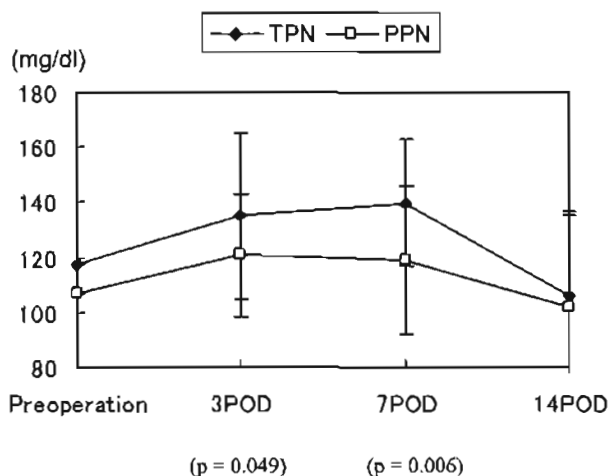


Fig. 4 Changes in the plasma glucose levels

tric cancer, and calculated the amount of energy consumed at rest from these measurement values. Based on these measurements and calculations, Yoneyama reported that the mean energy consumption was 26-29 kcal/kg/day before postoperative day 7. Theoretically, therefore, Yoneyama's results and observations suggest that TPN might be an appropriate strategy for nutritional management after surgery in gastric cancer patients. Actually, TPN is employed for nutritional management after gastrectomy in many institutions at present. According to the "Nutritional management after total gastrectomy with the combined resection of the pancreas and spleen for gastric cancer"⁵⁾, which was compiled based on the data of nutritional management after total gastrectomy from 8 major institutions in Japan in 1993, TPN was adopted after total

gastrectomy at all the institutions. According to a nationwide questionnaire survey on trophotherapy (nutritional therapy) conducted by Inoue et al. in 2001⁶⁾, the frequency of use of TPN in (postoperative) nutritional management after total gastrectomy was 78.0%.

In recent years, however, much attention has come to be focused on the complications of TPN, including complications related to the catheterization⁷⁾ and retention of the catheter⁸⁾, catheter sepsis⁹⁾, mycoses¹⁰⁾, hepatopathy¹¹⁾, and metabolic acidosis¹²⁾. According to Kidogawa et al.¹³⁾, 10.9% of 257 patients (elective operation in 196 and emergency operation in 61) receiving TPN after gastroenterological surgery developed catheter sepsis. Advances in the techniques and devices for anastomosis now allow safer anastomoses, which has also led to a tendency towards decrease of the fasting period after surgery. So, is TPN really necessary for the fasting period of approximately 1 week?

To resolve this debatable issue, the changes in the nutritional status and frequencies of infectious complications were comparatively investigated between groups receiving TPN and PPN for postoperative nutritional management after total gastrectomy at our department (total, 82 patients). In regard to the nutritional status, there were significant differences in the Alb and peripheral blood total lymphocyte count on postoperative day 14 between the two groups, while our results were completely contradictory to those by the studies cited above,

i.e., of high Alb in the PPN group and a high total lymphocyte count in the TPN group. As shown in Table 1, despite the higher total-calorie, glucose, and amino acid doses administered by total parenteral nutrition (TPN), on postoperative hospital day 14 the Alb value, a nutrition index, was higher in the partial parenteral nutrition (PPN) group. While it is possible that the 0.8 day shorter fasting period in the PPN group may have been involved, the results suggested that if postoperative fasting were about 6 to 7 days, TPN would not be involved in the improvement in nutritional status. On the other hand, the fact that the total lymphocyte count, an immunological parameter, was higher on hospital day 14, suggests that the TPN group was better in terms of cellular immune capacity.

In regard to the infectious complications, the frequencies of pyrexia and of infections tended to be higher in the TPN group, although there were no significant differences in these two parameters between the two groups. When considering the test items (WBC, CRP) reflecting the severity of infection, however, the serum CRP on postoperative day 3 was significantly ($p=0.039$) higher and the severity of infection tended to be higher in the TPN group. These results indicate that TPN might increase the risk of postoperative infections.

The Veterans Affairs Total Parenteral Nutrition Cooperative Study Group¹⁴ reported a high frequency of infectious complications in 395 patients receiving TPN for postoperative nutritional management after laparotomy, thoracotomy or total gastrectomy.

In recent years, the importance of strict control of plasma glucose in the perioperative period, in cases with acute coronary syndromes and in the intensive care setting has come to be recognized¹⁵. Control of the plasma glucose level in the range of 80-110 mg/dl by intensive conventional insulin therapy, as needed, is recommended¹⁶. In the present study, the plasma glucose levels on postoperative days 3 and 7 were significantly higher and exceeded the recommended range (135.0 ± 23.8 and 139.7 ± 31.0 mg/dl, respectively) in the TPN group as compared with the levels in the PPN group. This finding may also

account in part to the higher frequency of infectious diseases in the TPN group in the present assessment. Thus, close attention should be paid to the plasma glucose levels in the perioperative period in patients receiving TPN.

It is also important to compare medical expenses from the aspect of medical cost-effectiveness in Japan, and Ohtani et al.¹⁷ reported that the medical expenses associated with PPN were cheaper by 21,270 yen as compared with those entailed by TPN for nutritional therapy during the first 15 days of the postoperative period.

Subjects detected to have marked nutritional disorder because of the underlying disease (cancer, etc.) even prior to the surgery were excluded from this study, as also patients who developed serious postoperative complications, such as ruptured sutures. In such patients, with expected prolongation of fasting period, TPN may presumably be selected as usual.

The results of the present assessment indicate no merits of TPN over PPN for nutritional management after total gastrectomy. Therefore, taking into consideration the economic advantage, convenience of administration and safety, selection of PPN rather than TPN is recommended for nutritional management in patients undergoing gastrointestinal surgery who are found to have no significant nutritional disorder preoperatively and who do not develop any serious complications postoperatively.

Conclusions

PPN is recommended for as the nutritional management strategy in patients undergoing total gastrectomy without complications in the perioperative period.

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胃全摘術後の栄養管理についての検討—TPN と PPN を比較して—

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〔背景〕胃全摘術の周術期栄養管理を高カロリー輸液 (TPN) で行っている施設は少なくはない。しかし TPN に関連した合併症も無視できる頻度ではない。TPN は胃全摘術後に必要な栄養管理法であるのか。今回、胃全摘術の周術期栄養管理を TPN で行った症例と末梢輸液 (PPN) で行った症例を比較検討した。〔方法〕胃癌、悪性リンパ腫に対して、胃全摘術を施行し周術期栄養管理を TPN で行った 41 例と PPN で行った 41 例を対象とした。術前後の栄養状態の変化、感染性合併症の発症について比較、検討した。〔結果〕栄養状態の変化については、TP 値では差を認めなかった。Alb 値では 14 病日で PPN 群で有意に高値だった。末梢血リンパ球数では 14 病日で TPN 群で有意に高値だった。感染性合併症については、WBC の推移に差はなかったが CRP については 3 病日において TPN 群で有意に高値だった。血糖値は 3 病日と 7 病日が TPN 群で有意に高値だった。発熱症例、診断可能であった感染症は TPN 群で多い傾向だったが有意差はなかった。〔結論〕今回の検討の結果、胃全摘術の術後栄養管理としての TPN の有用性は認めず、合併症のない症例の胃全摘術周術期の栄養管理は PPN が基本であると考えられた。