



Original article

Reduced thiamine (vitamin B1) levels following gastrectomy for gastric cancer

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Abstract

Background. Vitamin B1 deficiency is well known as a possible complication following gastric restrictive surgery for morbid obesity; however, reduced vitamin B1 levels in patients who have undergone gastrectomy for gastric cancer have not been discussed previously.

Methods. Serum vitamin B1 levels were determined after the return to normal daily activity in 54 patients with distal gastrectomy for gastric cancer, 32 patients with total gastrectomy for gastric cancer, and 30 patients with radical surgery for colorectal cancer. Changes from serum vitamin B1 levels before operation to those after return to normal daily activity, without nutritional support, were investigated in 25 patients with gastrectomy for gastric cancer and 26 patients with radical surgery for colorectal cancer.

Results. Decreased serum vitamin B1 levels, below the normal range, were recognized in 7 of the 54 distally gastrectomized patients and in 5 of the 32 totally gastrectomized patients, whereas no such decrease was recognized in any patient after colorectal surgery. Decreased serum vitamin B1 level was recognized within 6 months after the operation in 6 of the 7 distally gastrectomized patients showing a decreased vitamin B1 level and in 3 of the 5 totally gastrectomized patients showing a decreased vitamin B1 level. Postoperative serum vitamin B1 levels were significantly lower than those before operation in patients with gastrectomies, whereas there was no significant difference in serum vitamin B1 levels before and after the surgeries in patients with surgery for colorectal cancer.

Conclusion. Vitamin B1 levels may be reduced in gastrectomized patients, especially within 6 months after operation, even after their return to normal daily activity without nutritional support.

Key words Gastrectomy · Thiamine · Vitamin B1

Introduction

Symptomatic vitamin B1 (Vit B1) deficiency is characterized by peripheral neuropathy (beriberi neuropathy) [1, 2] or Wernicke-Korsakoff encephalopathy [3]. Vit B1 deficiency is found in patients with prolonged fasting, protracted vomiting [4], malnutrition [5], and intermittent gastric outlet obstruction by pancreatic pseudocyst [6], as well as in patients with alcoholism, which is the most common causative factor [7]. Recently, Wernicke's encephalopathy following gastric restrictive surgeries for morbid obesity has been reported as one of the postoperative complications [4,5,8–13]. Some cases of peripheral neuropathy or Wernicke's encephalopathy caused by Vit B1 deficiency following gastrectomy for benign or malignant gastric lesions have been reported in the past decade in Japan. Outside the common situation of alcoholism, Wernicke's encephalopathy may be difficult to recognize, especially if it is in the early stage and if all manifestations are not yet present [8–13]. Early recognition or prediction of the possible occurrence of Vit B1 deficiency may be crucial, because a patient with Wernicke's encephalopathy may become comatose and die if the disorder is not diagnosed and thiamine not given promptly [4]. However, there is no previous report focusing on the possibility of Vit B1 deficiency following gastrectomy for gastric cancer, and the characteristics of serum Vit B1 levels in gastrectomized patients have not been discussed previously. The purpose of the present study was to investigate serum Vit B1 levels in patients undergoing gastrectomy for gastric cancer.

Table 1. Patients

		Age (years)	Sex (no. of patients)
Screening of preoperative serum Vit B1 levels	Gastric cancer ($n = 25$)	59 ± 13	M, 14; F, 11
	Colorectal cancer ($n = 21$)	64 ± 11	M, 12; F, 9
Screening of postoperative serum Vit B1 levels	Distal gastrectomy for gastric cancer ($n = 54$)	61 ± 8	M, 31; F, 23
	Total gastrectomy for gastric cancer ($n = 32$)	62 ± 11	M, 13; F, 12
Serial changes in serum Vit B1 levels before and after operation	Radical operation for colorectal cancer ($n = 30$)	66 ± 10	M, 18; F, 12
	Gastrectomy for gastric cancer ($n = 25$)	62 ± 11	M, 13; F, 12
	Radical operation for colorectal cancer ($n = 26$)	64 ± 11	M, 18; F, 8

Ages are expressed as means \pm SD
Vit B1, Vitamin B1

Subjects and methods

Screening of preoperative serum Vit B1 levels in patients with gastric or colorectal cancer

Preoperative serum Vit B1 levels were determined after an overnight fast in 25 patients with gastric cancer and 21 patients with colorectal cancer, between July 1998 and May 1999 (Table 1). Patients who complained of vomiting and who had received nutritional or vitamin support before surgery were excluded from the study.

Screening of serum Vit B1 levels in gastrectomized patients after their return to normal daily activity

Serum Vit B1 levels, 2 to 24 months after operation, were determined after an overnight fast in 54 patients who underwent distal gastrectomy for gastric cancer with reconstruction by the Billroth I method and in 32 patients who had undergone total gastrectomy for gastric cancer between April 1998 and May 1999. Reconstruction was performed by the Roux-en-Y method in 28 patients and by jejunal interposition in 4 patients in the totally gastrectomized patients. Thirty patients who underwent radical surgery for colorectal cancer served as controls; right hemicolectomy had been performed in 8 patients, anterior or low anterior resection in 13 patients, abdominoperineal resection in 4 patients, and other procedures in 5 patients (Table 1). None of the patients were receiving any nutritional or vitamin support at the time of determination of serum Vit B1 levels. Serum albumin levels at the time of determination of serum Vit B1 levels were within the normal range in all patients. Patients with obvious recurrent cancer which might have affected oral intake were excluded from enrollment in the study.

Serial changes in serum Vit B1 levels before and after gastrectomy

Between June 1999 and October 2000, serial changes in serum Vit B1 levels were determined, after an overnight

fast, before operation and after their return to normal daily activity, in 25 patients who underwent gastrectomy for gastric cancer (Table 1). Informed consent was obtained from each patient for these determinations. Distal gastrectomy with reconstruction by the Billroth I method was performed in 15 patients and total gastrectomy with reconstruction by the Roux-en-Y method was performed in ten patients. Twenty-six patients who underwent radical surgery for colorectal cancer served as controls; right hemicolectomy was performed in 6 patients, anterior or low anterior resection in 11 patients, abdominoperineal resection in 3 patients, and other procedures in 6 patients. The interval between surgery and the postoperative determination of serum Vit B1 levels was 72 ± 12 days (range, 58–115) days. None of the patients were receiving any nutritional or vitamin support at the time of determination of serum Vit B1 levels before or after surgery. All patients had returned to their normal daily activity at the time of determination of postoperative serum Vit B1 levels. Patients with obvious remnant tumor which might have affected oral intake were excluded from the study. Postoperative total parenteral nutrition, consisting of 60 g of free amino acids, 360 g of dextrose (1680 kcal/day), and 5 mg of thiamine chloride per day, was given to 9 patients; the duration of parenteral nutrition was 11 ± 4 days.

Serum Vit B1 levels were determined by high performance liquid chromatography after an overnight fast. The normal range was determined as 20–50 ng/ml from the mean \pm 2 SD value of 144 healthy volunteers.

Data values are expressed as means \pm SD. For the evaluation of serial changes, the paired *t*-test was used. Association between variables was determined with the γ correlation index. Data values were computed with the software program Stat View 5.0 (HULINKS, Tokyo, Japan). *P* values less than 0.05 were considered significant.

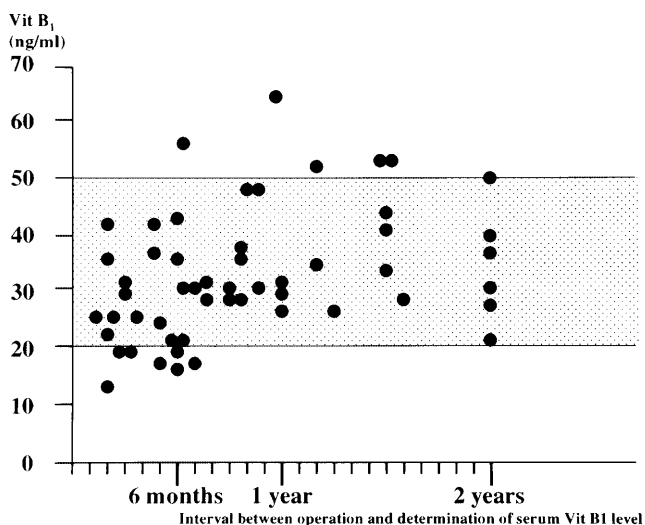


Fig. 1. Serum vitamin B1 (*Vit B1*) levels in distally gastrectomized patients. *Shaded area* represents the normal range of serum Vit B1 levels, 20–50ng/ml

Results

Preoperative serum Vit B1 levels in patients with gastric or colorectal cancer

Decreased serum Vit B1 levels below the normal range were not recognized preoperatively in any patient with gastric or colorectal cancer. The preoperative serum Vit B1 level was the same as the lowest value of the normal range, 20ng/ml, in only 1 of the 25 patients with gastric cancer and in only 1 of the 21 patients with colorectal cancer. These data suggest that Vit B1 deficiency is not frequent before elective surgery in patients with gastric or colorectal cancer when patients do not require preoperative nutritional support.

Serum Vit B1 levels in gastrectomized patients after their return to normal daily activity

Decreased serum Vit B1 levels below the lowest value of the normal range were recognized in 7 of the 54 distally gastrectomized patients (13%) and 5 of the 32 totally gastrectomized patients (16%), while there was no such decrease in any patient after radical surgery for colorectal cancer (Figs. 1, 2, 3). In the distally gastrectomized patients, the decreased serum Vit B1 level was recognized in 6 of 22 patients (27%) within 6 months after the operation and in 7 of 39 patients (18%) within 1 year after the operation, while it was not recognized more than 1 year after the operation (Fig. 1). In the totally gastrectomized patients, the decreased serum Vit B1 level was recognized in 3 of 12 patients (25%) within 6 months after the operation and in 4 of 24 patients (17%) within 1 year after operation, while it was recog-

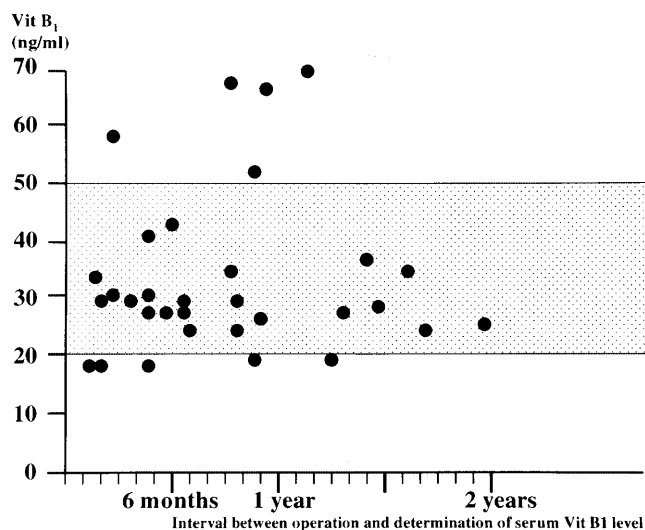


Fig. 2. Serum Vit B1 levels in totally gastrectomized patients. *Shaded area* represents the normal range of serum Vit B1 levels, 20–50ng/ml

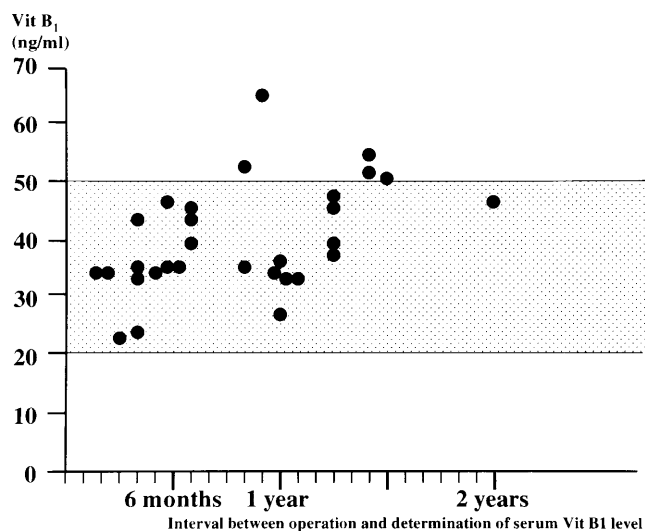


Fig. 3. Serum Vit B1 levels in patients who underwent radical surgery for colorectal cancer. *Shaded area* represents the normal range of serum Vit B1 levels, 20–50ng/ml

nized in only 1 of 8 patients more than 1 year after the operation (Fig. 2). There was no significant correlation between the serum Vit B1 levels and the interval from surgery to the determination of serum Vit B1 levels in patients with distal gastrectomy, total gastrectomy, or radical surgery for colorectal cancer. There were no neurological disorders suggestive of Wernicke's encephalopathy or peripheral polyneuropathy in any patients. These data suggest that reduced Vit B1 levels may be frequent in gastrectomized patients, especially within 6 months after the operation even after their return to normal daily activity without any nutritional support.

Serial changes in serum Vit B1 levels before and after gastrectomy

In the patients with gastrectomy, postoperative serum Vit B1 levels after their return to normal daily activity without any nutritional support were significantly lower than those before operation. The postoperative serum Vit B1 level was lower than the lowest value of the normal range in 3 of the 25 patients and was the same as the lowest value of the normal range in 4 of the 25 patients (Fig. 4). There was no significant difference in serum Vit B1 levels between measurements obtained before and after surgery in patients who underwent radical surgery for colorectal cancer (Fig. 5). In patients with gastrectomies, there was no significant correlation

between postoperative serum Vit B1 levels and the ratio of decrease in body weight to preoperative body weight or between postoperative serum Vit B1 levels and postoperative serum albumin levels (Fig. 6). These data demonstrate that without any nutritional support, gastrectomy may result in reduced Vit B1 levels even after the return to normal daily activity.

Discussion

Body stores of vitamins and minerals vary tremendously. The Vit B1 store is extremely small, and Vit B1 may become depleted within weeks when there is a

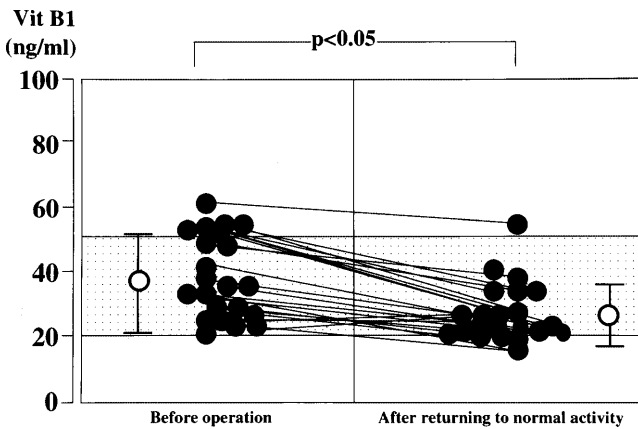


Fig. 4. Serial changes in serum Vit B1 levels before operation and after returning to normal daily activity without nutritional support in patients with gastrectomy. Closed circles represent each patient. Open circles and error bars represent means \pm SD. Shaded area represents the normal range of serum Vit B1 levels, 20–50 ng/ml

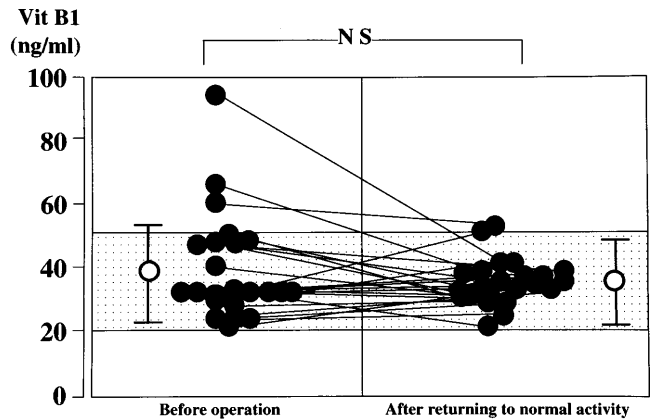


Fig. 5. Serial changes in serum Vit B1 levels before operation and after returning to normal daily activity without nutritional support in patients with radical surgery for colorectal cancer. Closed circles represent each patient. Open circles and error bars represent means \pm SD. Shaded area represents the normal range of serum Vit B1 levels, 20–50 ng/ml. NS, Not significant

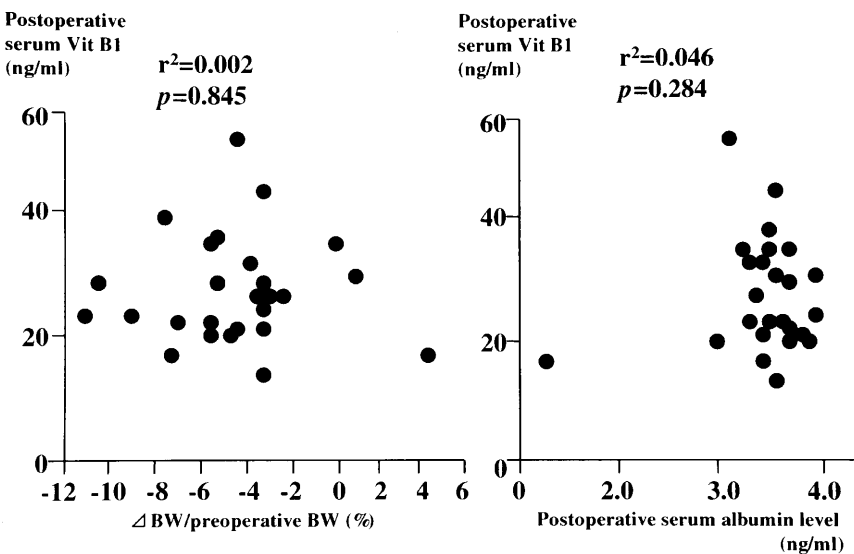


Fig. 6. Correlation between postoperative serum Vit B1 level and the ratio of postoperative decrease in body weight (BW) to preoperative body weight (left) and correlation between postoperative serum Vit B1 level and postoperative serum albumin level (right)

deficient diet, while, for example, vitamin B12 and vitamin A stores are large, and an adult may not become deficient for 1 or more years after being on a depleted diet [7]. There was no correlation between postoperative serum Vit B1 levels and the interval from gastrectomy to the determination of serum Vit B1 levels in the present study; this phenomenon is considered to be one of the characteristics of Vit B1, which has limited body stores. Our screening data of serum Vit B1 levels in gastrectomized outpatients demonstrated that gastrectomized patients sometimes developed reduced Vit B1 levels even when they had returned to normal daily activities without any nutritional support. The reduced Vit B1 levels in gastrectomized patients were recognized more frequently within 6 months after the operation. Total oral intake may be insufficient, especially within 6 months after gastrectomy. There is a possibility that the oral intake of Vit B1 may be insufficient, especially within 6 months after gastrectomy, even after the return to normal daily activity without nutritional support. It has been reported that acute syndromes of Wernicke's encephalopathy and severe acute polyneuropathy appeared within 3 months after gastric restrictive surgery for morbid obesity, characterized by accelerated weight loss, low protein and caloric intake, and frequent vomiting in some patients [4,8,10]. The present data, however, revealed that there may be patients with reduced Vit B1 levels among gastrectomized patients, although the routine laboratory data, such as serum albumin levels, did not demonstrate any abnormalities and the patients did not complain of vomiting. It is clinically significant that the reduced Vit B1 levels in gastrectomized patients who had returned to normal activity without nutritional support cannot be predicted by routine laboratory data or evaluations of body weight.

Wernicke's encephalopathy or polyneuropathy caused by Vit B1 deficiency is a well-known postoperative complication following gastric restrictive surgery for morbid obesity [4,5,8–13]. Accelerated decrease in oral intake and frequent vomiting is considered to be one of the most important factors in the occurrence of symptomatic Vit B1 deficiency following gastric restrictive surgery for morbid obesity, especially in patients with symptoms recognized during the early postoperative period [4]. There is no previous report describing symptomatic or asymptomatic Vit B1 deficiency after distal or total gastrectomy for gastric cancer in the English-language literature. Nine cases of Wernicke's encephalopathy or peripheral neuropathy caused by Vit B1 deficiency following gastrectomy have been reported in the past decade in Japan [14]. Wernicke's encephalopathy or peripheral neuropathy occurred despite the patients' return to usual daily living without any nutritional support in these nine patients. Primary

food sources for Vit B1 include yeast, pork, legumes, beef, whole grains, and nuts. Milled and polished rice contains little, if any, Vit B1. Vit B1 deficiency is therefore more common in cultures that rely heavily on a rice-based diet [7]. Furthermore, raw fish and shellfish contain thiaminases, which can destroy the vitamin [7]. Japanese are fond of eating milled and polished rice and raw fish. There is a possibility that the baseline Vit B1 intake for body stores may be lower in Japan compared with that in Western countries. However, a significant decrease in serum Vit B1 levels caused by gastrectomy even after the return to normal activities without nutritional support was demonstrated by serial measurements obtained before and after gastrectomy in the present study. These tendencies are not considered to be due to Japanese culture, because the patients consumed almost the same kinds of foods after discharge from hospital as they did before surgery. A decrease in serum Vit B1 levels was not recognized after colorectal surgery. The significant decrease in postoperative serum Vit B1 level even after the return to normal daily activity is, therefore, considered to be characteristic of gastrectomy.

The screening data in the present study indicate that the frequency of the decrease in serum Vit B1 levels below the normal range after distal gastrectomy with reconstruction by the Billroth I method was almost equal to that after total gastrectomy with reconstruction by the Roux-en-Y method. These data suggest that the method of reconstruction may not play an important role in postoperative serum Vit B1 levels. It has been reported that Vit B1 is mainly absorbed through the jejunum in rats and through the jejunum and ileum in guinea-pigs [15,16]. At high doses, Vit B1 is absorbed by a passive mechanism; at low doses, it is absorbed by a carrier-mediated, active transport system [7]. Vit B1 is easily destroyed under alkaline conditions, especially at a pH of more than 8 [7]. Increased pH in the upper alimentary tract following distal or total gastrectomy is considered to be one of the causative factors for the postoperative decrease in serum Vit B1 levels after gastrectomy.

Early recognition of Wernicke's encephalopathy or peripheral neuropathy caused by Vit B1 deficiency may be crucial, considering the poor prognosis without appropriate treatment [4]. The progression toward death may be accelerated by giving dextrose intravenously, because glucose metabolism drains the body's last reserves of Vit B1 [4]. Furthermore, the possible occurrence of lactic acidosis caused by intravenous hyperalimentation in conditions with Vit B1 deficiency has been reported previously [17,18]. The neurological signs of thiamine depletion may be completely eliminated if Vit B1 is given promptly. If Vit B1 treatment is delayed, the neurological deficiencies often become

permanent, and the patient may become an invalid for the remainder of his or her life [4]. The clinical message of the present study is the possible existence of reduced Vit B1 levels in gastrectomized patients even after their return to their normal activities without nutrition support. Furthermore, reduced Vit B1 levels after gastrectomy cannot be predicted by routine laboratory data such as serum albumin levels and postoperative decrease in body weight. Attention should be paid to reduced Vit B1 levels following gastrectomy, especially within 6 months after the operation.

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