

Nutritional risk index as a predictor of postoperative wound complications after gastrectomy

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Abstract

AIM: To investigate the correlation between the nutritional risk index (NRI) and postoperative wound complications.

METHODS: From January 2008 through June 2008, 669 patients who underwent curative gastrectomy for gastric cancer were included in a retrospective study. Medical records of consecutive patients were collected and analyzed to determine postoperative wound complication rates. The NRI was assessed on the fifth postoperative day and other possible risk factors for the incidence of wound complications were analyzed to identify the factors affecting postoperative wound

complications. Patients with other postoperative complications were excluded from the study.

RESULTS: On the 5th postoperative day, the NRI showed a malnutrition rate of 84.6% among postoperative patients. However, postoperative wound complications occurred in only 66/669 (9.86%) patients. Of the patients with wound complications, 62/66 (94%) belonged to the malnourished group ($\text{NRI} < 97.5$), and 4/66 (6%) patients to the non-malnourished group ($\text{NRI} \geq 97.5$). The only factor correlated with wound complications was the NRI on the 5th postoperative day (odds ratio of $\text{NRI} \geq 97.5$ vs $\text{NRI} < 97.5$: 0.653; 95% confidence interval: 0.326-0.974; $P = 0.014$) according to univariate analysis as well as multivariate analysis.

CONCLUSION: This study suggests that malnutrition immediately after surgery may play a significant role in the development of wound complications.

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Key words: Nutritional risk index; Wound complication; Gastric cancer

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INTRODUCTION

Gastric cancer is the second most common cancer in the world, the most common cancer in South Korea, and the third common cause of cancer death in South Korea^[1,2]. A successful outcome after surgery is highly dependent on the incidence and severity of postoperative complications, and malnutrition has been reported to be an important risk factor for perioperative morbidity and mortality^[3]. Bozzetti *et al*^[4] found that low serum albumin was one of the factors correlated with postoperative complications. Weight loss has also been shown to identify patients at risk of postoperative complications^[5].

Wound infection has been one of the most common postoperative complications associated with surgical treatment of patients^[6,7]. Its occurrence may significantly contribute to increased postoperative morbidity and longer duration of hospitalization. Typically reported risk factors for wound breakdown were duration of surgery, obesity, diabetes, patient age, coincident infection, and poor nutrition^[8,9].

In a previous study, it was demonstrated that low serum albumin on the 5th day after surgery was well correlated with postoperative short-term complications^[10]. It was also shown that a total of 13.45% patients developed postoperative complications, of which 55% were related to wound complications. Based on these previous data, it was assumed that malnourished patients might have a high rate of postoperative wound complications, as well as other postoperative complications. It is vital to detect and treat malnutrition in patients undergoing major surgery, because malnutrition results in poor clinical outcomes if unrecognized and not treated properly.

Thus, a proper assessment of the nutritional status in these patients should be performed. Numerous researchers have sought a reliable, valid scoring system that can identify patients with poor nutritional status^[11]. Many nutrition risk scores to predict nutrition-related complications in gastrointestinal surgery are available, including the nutrition risk index (NRI), the nutrition risk score, and the bioelectrical impedance analysis^[3]. None of these is generally accepted as the gold standard. Among them, the NRI, which is based on the serum albumin concentration and weight loss, has been shown to identify patients at risk for postoperative complications^[3]. NRI is based on a mathematical equation, can easily be scored after one laboratory test, does not require subjective judgment, and can be safely applied in the clinical setting, with no significant effect on the predictive value^[11]. On the other hand, other nutritional assessment techniques are based on clinical and subjective assessments, so can be variable between observers.

For this reason, the NRI was chosen as the index reflecting the nutritional state of the postoperative patient in this study. We aimed to evaluate the correlation of the NRI with wound complications in gastric cancer patients undergoing curative gastrectomy, and to determine strategies to support postoperative patients' nutritional status in order to reduce postoperative complications, includ-

Table 1 Types and definitions of wound complications

Types	Definitions
Seroma	Serous fluid collection in the absence of infection
Hematoma	Subcutaneous blood in the absence of infection
Wound infection	Displayed two or more of the following characteristics: drainage of purulent material, erythema, tenderness, induration or fever
Wound dehiscence	(1) Hematoma, seroma, or infection that required that the incision be opened, evacuated, and/or irrigated and debrided; (2) Status that required packing and healing by secondary intention

From Chelmsow *et al*^[9] 2004.

ing wound complications.

MATERIALS AND METHODS

Patients

From January 2008 through June 2008, 669 patients who underwent curative gastrectomy for gastric adenocarcinoma at Samsung Medical Center were enrolled in a retrospective study, with data collected prospectively. Medical records of consecutive patients were analyzed to determine the postoperative wound complication rates and to examine the effect of other possible risk factors of wound complications. Gender, age, disease progression, types of operation, comorbid disease and nutritional status were reviewed and analyzed as the possible risk variables. Postoperative wound complications which developed during the hospital stay, and the types of wound complications were classified according to Table 1. The patients with other postoperative complications were excluded because these might affect the occurrence of postoperative wound complications and could act as confounding factors.

Nutritional assessment

The nutritional assessment of the patients was performed using the NRI on the 5th postoperative day. The NRI was calculated using the formula: $NRI = (1.489 \times \text{serum albumin, g/L}) + (41.7 \times \text{current weight/usual weight})^{[3]}$. The usual weight was defined as the stable weight 6 mo or more before illness^[11], but in this study, the weight measured at admission was used as the usual weight. The present weight was also determined on the 5th postoperative day using a calibrated balance. It has been suggested that a $NRI > 100$ indicated that the patient is not malnourished, while 97.5-100 indicated mild malnourishment, 83.5-97.5 indicated moderate malnourishment, and < 83.5 indicated severe malnourishment^[11,12]. However, in this study, the cutoff points suggested by Buzby *et al*^[13] were used to define malnutrition for the NRI. Therefore, patients with a score ≥ 97.5 were classified as well nourished, between 83.5 and 97.5 as moderately malnourished, and below 83.5 as severely malnourished. For analysis, the patients were stratified into two groups: a well-nourished group with a NRI score ≥ 97.5 and a moderately or severely malnourished group with a NRI score below 97.5. The

Table 2 Characteristics of patients according to the nutritional risk index on the 5th postoperative day

Characteristic		NRI			P value
		< 97.5 (n = 566, 84.6%)	≥ 97.5 (n = 103, 15.4%)	All (n = 669)	
Gender, n (%)	Male	346 (61)	86 (83)	432	0.000 ¹
	Female	220 (39)	17 (17)	237	
Age, mean ± SD		57.15 ± 11.7	54.70 ± 9.69	56.77 ± 11.44	0.035 ²
Disease progression, n (%)	EGC	307 (54)	72 (70)	379	0.003 ¹
	AGC	259 (46)	31 (30)	290	
Type of operation, n (%)	B- I	355 (63)	89 (86.4)	444	0.000 ¹
	B- II	61 (11)	5 (4.9)	66	
	TG	150 (26)	9 (8.7)	159	
Comorbid diseases, n (%)	Hypertension	130 (23)	29 (28.1)	159	0.365 ¹
	Diabetes mellitus	66 (11.7)	20 (19.4)	86	
	Pulmonary tuberculosis	22 (3.9)	7 (6.8)	29	
	Cardiovascular diseases	13 (2.3)	3 (2.9)	16	
	Hepatitis	40 (7.1)	5 (4.8)	45	
	Others	18 (3)	1 (1)	19	
	None	277 (50)	38 (36.9)	315	
Postoperative hospital stay (d, mean ± SD)		12.76 ± 4.02	12.01 ± 2.45	12.64 ± 3.82	0.160 ²
Postoperative wound complication, n (%)		62 (10.9)	4 (3.8)	66 (9.86)	0.027 ¹

NRI: Nutrition risk index; EGC: Early gastric cancer; AGC: Advanced gastric cancer; B- I : Subtotal gastrectomy with Billroth- I reconstruction; B- II : Subtotal gastrectomy with Billroth- II reconstruction; TG: Total gastrectomy. ¹Fisher's exact test; ²Mann-Whitney *U* test.

NRI characteristics of patients, as well as the postoperative wound complication rate (%), were compared between the two groups and evaluated for their association with wound complications. To clarify the factors affecting postoperative wound complication, logistic regression analysis were performed.

Statistical analysis

The characteristics of patients, operation types, medical comorbid disease, length of postoperative hospital stay, and wound complications were compared based on the NRI classification using Fisher's exact test (Chi-squared) and the Mann-Whitney *U* test. In addition, these variables were compared between the groups with wound complications and those without wound complications using the same statistical methods and a repeated analysis of variance test, where appropriate. A difference was considered significant at $P < 0.05$. All statistical analyses were performed using the statistical software package PASW 17.

RESULTS

A total of 669 patients who had undergone curative gastrectomy for gastric cancer were enrolled in the study. The mean age was 56.8 ± 11.4 years. The ratio of males to females was 1.8:1 (432/237). The majority of the patients, 379 (56.7%) had early gastric cancers, while 290 (43.7%) had advanced gastric cancers. Early gastric cancer is defined as tumor invasion limited to the mucosa and submucosa, irrespective of the presence of a lymph node metastasis, and advanced gastric cancer is defined as tumor invasion above the muscularis propria^[14].

Most patients [$n = 444$ (66.4%)] underwent subtotal gastrectomy with Billroth- I reconstruction, 66 (9.8%)

underwent subtotal gastrectomy with Billroth- II reconstruction, and 159 (23.8%) patients underwent total gastrectomy. Co-morbid diseases were present in 354 (52.9%) patients, with the most common being hypertension (23.7%), followed by diabetes mellitus (12.9%), hepatitis (6.7%), pulmonary tuberculosis (4.3%), and cardiovascular diseases (2.3%).

The clinical demographic characteristics are described in Table 2. Patients were stratified on the basis of the NRI on the 5th postoperative day (NRI < 97.5, malnourished or NRI ≥ 97.5, not malnourished). Malnutrition rates on the 5th postoperative day were 84.6% (566/669), with 3% (21/669) of the patients showing severe malnutrition (NRI < 83.5), 81.5% (545/669) showing moderate malnutrition ($83.5 \leq \text{NRI} < 97.5$).

As shown in Table 2, there were statistically significant differences in gender, age, disease progression, types of operation, and postoperative wound complication rates between NRI classes. However, there were no statistically significant differences in comorbid diseases or length of postoperative hospital stay between NRI classes. Postoperative wound complications occurred in 66 (9.86%) of the 669 patients. Among these patients, 62 (94%) belonged to the malnourished group (NRI < 97.5), and 4 (6%) patients to the non-malnourished group (NRI ≥ 97.5).

Table 3 shows the patient characteristics, or risk factors, that correlate with wound complications. The only risk factor that correlated with wound complications was the NRI on the 5th postoperative day. By contrast, there were no differences in the rates of wound complications with respect to gender, age, disease progression, type of operation, or comorbid diseases. As expected, in patients who developed wound complications, length of postoperative hospital stay was prolonged.

Table 3 Relationship between patient characteristics and occurrence of wound complications

Characteristic		Wound complication			P value
		(-) (n = 603)	(+) (n = 66)	All (n = 669)	
Gender, n (%)	Male	393 (65.2)	39 (59.1)	432	0.327 ¹
	Female	210 (34.8)	27 (40.9)	237	
Age, mean ± SD		56.57 ± 11.2	58.62 ± 13.2	56.77 ± 11.44	0.164 ²
Disease progression, n (%)	EGC	346 (57.4)	33 (50)	379	0.251 ¹
	AGC	257 (42.6)	33 (50)	290	
Type of operation, n (%)	B- I	404 (67)	40 (60.6)	444	0.253 ¹
	B- II	61 (10)	5 (7.6)	66	
	TG	138 (23)	21 (31.8)	159	
Comorbid diseases, n (%)	Hypertension	142 (23.5)	17 (25.8)	159	0.722 ¹
	Diabetes mellitus	73 (12.1)	20 (30.3)	93	
	Pulmonary tuberculosis	26 (4.3)	7 (10.6)	33	
	Cardiovascular diseases	16 (2.7)	0 (0)	16	
	Hepatitis	40 (6.6)	5 (7.6)	45	
	Others	17 (2.8)	2 (3)	19	
	None	289 (48)	15 (22.7)	304	
Postoperative hospital stay (d, mean ± SD)		12.24 ± 3.25	16.38 ± 6.104	12.64 ± 3.82	0.000 ²
NRI, n (%)	NRI < 97.5	504 (83.6)	62 (93.9)	566	0.027 ¹
	NRI ≥ 97.5	99 (16.4)	4 (6.1)	103	

NRI: Nutrition risk index; EGC: Early gastric cancer; AGC: Advanced gastric cancer; B- I : Subtotal gastrectomy with Billroth- I reconstruction; B- II : Subtotal gastrectomy with Billroth- II reconstruction; TG: Total gastrectomy. ¹Fisher's exact test; ²Mann-Whitney U test.

Table 4 Distribution of types of wound complications according to the nutritional risk index

	NRI	
	< 97.5 n = 62	≥ 97.5 n = 4
Seroma	36	0
Hematoma	4	0
Wound infection	9	0
Wound dehiscence	13	4
Total	62	4

NRI: Nutrition risk index.

As shown in Table 4, the most common wound complication was seroma. It was encountered in 36 (54.5%) patients, all of whom were malnourished. Seventeen (25.8%) of the patients developed wound dehiscence, which required gauze packing and healing by secondary intention. Thirteen (70%) of these patients belonged to the malnourished group. Nine patients (13.6%) had wound infection, which required draining of purulent material in all cases and treatment with antibiotics in some cases. Three (13.6%) of the patients had hematoma that required evacuation. These patients were all malnourished.

When wound complications were correlated with the six possible risk factors by logistic regression analysis, the only factor that significantly increased the rate of wound complication was the 5th postoperative NRI of the malnourished group (Table 5).

DISCUSSION

It has been well known that malnutrition is a significant

Table 5 Multivariate analysis of characteristics of patients with wound complications by logistical regression

	Odds ratio (95% CI)	P value
Age (≥ 56.77 vs < 56.77)	1.299 (0.829-2.035)	0.253
Gender (male vs female)	1.253 (0.795-1.976)	0.330
Disease progression (AGC vs EGC)	1.363 (0.873-2.127)	0.157
Surgical methods:		0.400
B- II vs B- I	0.839 (0.365-1.930)	0.679
TG vs B- I	1.511 (0.920-2.483)	0.103
Comorbid diseases		NS
NRI (≥ 97.5 vs < 97.5)	0.653 (0.326-0.974)	0.014

NRI: Nutrition risk index; EGC: Early gastric cancer; AGC: Advanced gastric cancer; B- I : Subtotal gastrectomy with Billroth- I reconstruction; B- II : Subtotal gastrectomy with Billroth- II reconstruction; TG: Total gastrectomy; NS: Not significant; CI: Confidence interval.

risk factor for postoperative complications in major abdominal surgery^[15]. The reported prevalence of malnutrition in gastrointestinal surgery patients ranges from 30% to 50%^[3,16]. Kuzu *et al*^[11] reported that the level of malnourishment was directly correlated with both the severity and the frequency of postoperative complications. Beattie also suggested that perioperative nutritional support in malnourished patients decreased postoperative complications such as wound infections and sepsis^[16].

It was reported that serum albumin on the 5th day after surgery was correlated with postoperative short-term complications^[10]. It was also shown that 13.45% of the patients developed postoperative complications and that 24% of these patients had hypoalbuminemia on the 5th postoperative day. Furthermore, 55% of the postoperative complications were wound complications. Gorman *et al*^[17] suggested that malnutrition was an important risk factor for postoperative infections and wound com-

plications in patients undergoing major surgery.

An accurate and reliable method for identifying patients who are malnourished or at risk for malnutrition may be beneficial in preventing postoperative infections and wound complications^[11]. Many simple nutritional assessment or screening tools have been developed in recent years and have been validated^[18]. Among them, the NRI, based on serum albumin concentration and weight loss, has been shown to identify patients at risk of postoperative complications. Its value, however, is limited by non-nutritional factors that affect albumin synthesis and the fact that the score does not represent specific, disease-related nutritional risk, such as in cancer. Nonetheless, it is simple, reliable, and does not require subjective judgment^[11].

In the present study, it was found that the NRI on the 5th postoperative day identified 566 (84.6%) malnourished patients and that 10.9% of these malnourished patients developed wound complications. The NRI on the 5th postoperative day was the only risk factor for wound complications which was a new finding in gastric surgery.

However, patients with severe malnutrition [serum albumin < 3.0 g/dL or weight loss > 10% or body mass index (BMI) < 18.5 kg/m²] did not show a significantly higher incidence of postoperative complications^[4]. Additionally, weight loss and hypoalbuminemia were not associated with an increased risk of mortality and morbidity in patients who underwent surgery for gastric cancer^[15]. Some recent evidence suggested that overweight and obesity rather than malnutrition were significant risk factors for postoperative complications in major abdominal surgery^[19]. With respect to wound complications, Shin *et al*^[20] reported that overweight (BMI > 25.0 kg/m²) patients that underwent gastrectomy had a higher wound complication rate than normal body weight (BMI ≤ 25.0 kg/m²) patients. Furthermore, Jaibati reported that overweight at the time of surgery, as measured by increased BMI, was a significant risk factor for an increased wound complication rate following abdominoplasty^[21]. In addition, Vastine *et al*^[22] reported that for abdominoplasties, 80% of obese patients had complications compared with the borderline and non-obese patients, and Hester *et al*^[23] showed that in abdominoplasty procedures, obesity was a significant factor in predicting major morbidity.

Bearing in mind that other factors in addition to nutritional status may be involved in the development of postoperative complications, analyses were conducted in this study to identify possible risk factors, but no other factors were correlated with wound complications. In particular, and in contrast to common expectations that diabetes mellitus may be related to wound complications, there was no association between comorbidities, including diabetes mellitus, and wound complications, which contradicted the reports related to other surgical procedures. For example, Hensel *et al*^[24] found that in abdominoplasty, complications were significantly increased in patients with diabetes and/or hypertension, and Jabaiti^[21]

found a negative correlation between diabetes mellitus and wound complications. It was also suggested that malnutrition was not always the cause of postoperative complications, but that both malnutrition and complications were the result of the underlying disease or other factors, because malnutrition and underlying disease were inextricably interwoven.

In conclusion, it was clearly shown that malnutrition had a high correlative relationship with postoperative wound complications, and NRI on the 5th postoperative day was a very good predictor of wound complications in gastric resection.

COMMENTS

Background

It was supposed that malnutrition might be related with postoperative wound complication. Nutritional risk index (NRI) was used as an evaluation tool of nutritional status in this study because it was easy and convenient to be applied.

Research frontiers

Surgical metabolism and clinical nutrition are important areas in the research field related with this article.

Innovations and breakthroughs

NRI on the 5th postoperative day was a good predictor of postoperative wound complications.

Applications

Preoperative or postoperative nutritional support, especially with attention to serum level of albumin may reduce wound complications.

Terminology

NRI is calculated with serum albumin level and body weight to evaluate nutritional status of patients.

Peer review

Authors showed that NRI on the 5th postoperative day was useful to predict postoperative wound complications.

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