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

Cheong Ah Oh, Dae Hoon Kim, Seung Jong Oh, Min Gew Choi, Jae Hyung Noh, Tae Sung Sohn, 
Jae Moon Bae, Sung Kim

AIM: To investigate the correlation between the nutritional risk index (NRI) and 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 (NRI < 97.5), and 4/66 (6%) patients to the non-malnourished group (NRI ≥ 97.5). The only factor correlated with wound complications was the NRI on the 5th postoperative day (odds ratio of NRI ≥ 97.5 vs 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.

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

Peer reviewers: Wei-Dong Tong, Dr., MD, PhD, Associate Professor, Daping Hospital, Third Military Medical University, Chongqing 400042, China; Takaaki Arigami, MD, PhD, Field of Oncology, Department of Surgical Oncology and Digestive Surgery, Kagoshima University Graduate School of Medical and Dental Sciences, 8-35-1 Sakuragaoka, Kagoshima 891-0175, Japan

Oh CA, Kim DH, Oh SJ, Choi MG, Noh JH, Sohn TS, Bae JM, Kim S. Nutritional risk index as a predictor of postoperative wound complications after gastrectomy. World J Gastroenterol 2012; 18(7): 673-678 Available from: URL: http://www.wjgnet.com/1007-9327/full/v18/i7/673.htm DOI: http://dx.doi.org/10.3748/wjg.v18.i7.673
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[3-2]. 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[9].

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. Many researchers have sought a reliable, valid scoring system that can identify patients with poor nutritional status[11-12]. 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[9]. 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[11]. 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 |
| Serum collection | 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 Chelmow 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, type 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 × serum albumin, g/L) + (41.7 × current weight/normal weight)[3]. The usual weight was defined as the stable weight 6 mo or more before illness[13], 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 83.5-97.5 indicated moderate malnourishment, and < 83.5 indicated severe malnourishment. 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 < 97.5 (n = 566, 84.6%) | NRI ≥ 97.5 (n = 103, 15.4%) | All (n = 669) | P value |
|------------------------------------|-----------------------------|-----------------------------|---------------|---------|
| Gender, n (%)                      | Male                        | 346 (61)                    | 86 (83)       | 432     | 0.0006 |
|                                   | Female                      | 220 (39)                    | 17 (17)       | 237     | 0.6842 |
| Age, mean ± SD                     | Male                        | 57.15 ± 11.7                | 54.70 ± 9.69  | 56.77 ± 11.44 | 0.0358 |
|                                   | Female                      | 74 (72)                     | 70 (70)       | 144     | 0.003 |
| Disease progression, n (%)         | EGC                         | 259 (46)                    | 31 (30)       | 290     | 0.1605 |
|                                   | AGC                         | 355 (63)                    | 89 (86.4)     | 444     | 0.0002 |
| Type of operation, n (%)           | B-I                         | 61 (11)                     | 5 (4.9)       | 66      | 0.0002 |
|                                   | B-II                        | 150 (26)                    | 9 (8.7)       | 159     | 0.0002 |
| Comorbid diseases, n (%)           | Hypertension                | 130 (23)                    | 29 (28.1)     | 159     | 0.0357 |
|                                   | Diabetes mellitus           | 66 (11.7)                   | 20 (19.4)     | 86      | 0.0783 |
|                                   | Pulmonary tuberculosis      | 22 (3.9)                    | 7 (6.8)       | 29      | 0.0708 |
|                                   | Cardiovascular diseases     | 13 (2.3)                    | 3 (2.9)       | 16      | 0.0773 |
|                                   | Hepatitis                   | 40 (7.1)                    | 5 (4.8)       | 45      | 0.054 |
|                                   | Others                      | 18 (3)                      | 1 (1)         | 19      | 0.1964 |
|                                   | None                        | 277 (50)                    | 38 (36.9)     | 315     | 0.0002 |
| Postoperative hospital stay (d, mean ± SD) | 12.76 ± 4.02               | 12.01 ± 2.45               | 12.64 ± 3.82  | 0.1605 |
| Postoperative wound complication, n (%) | 62 (10.9)                 | 4 (3.8)                     | 66 (9.86)     | 0.027 |

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. *Fisher’s exact test; †Mann-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 was 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.

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). Malnourishment rates on the 5th postoperative day were 84.6% (566/669), with 3% (21/669) of the patients showing severe malnourishment (NRI < 83.5), 81.5% (545/669) showing moderate malnourishment (83.5 ≤ 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) | NRI < 97.5 (n=669) |
| Gender, n (%)               | Male | 393 (65.2) | 39 (59.1) | 432 | 0.327<sup>1</sup> |
|                            | 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<sup>1</sup> |
| Disease progression, n (%)  | EGC | 346 (57.4) | 33 (50) | 379 | 0.251<sup>1</sup> |
|                            | AGC | 257 (42.6) | 33 (50) | 290 |           |
| Type of operation, n (%)    | B- I | 404 (67) | 40 (60.6) | 444 | 0.253<sup>1</sup> |
|                            | 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<sup>1</sup> |
|                            | 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 | 0.002<sup>2</sup> |
| NRI, n (%)                  | NRI < 97.5 | 504 (83.6) | 62 (93.9) | 566 | 0.027<sup>3</sup> |
|                            | 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. *Fisher’s exact test; †Mann-Whitney U test.

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

| Characteristic | NRI < 97.5 (n=62) | NRI ≥ 97.5 (n=4) |
|----------------|-------------------|------------------|
| Seroma         | 36 (59.7%) | 0 (0%) |
| Hematoma       | 4 (6.5%)   | 0 (0%)   |
| Wound infection| 9 (14.5%)  | 0 (0%)  |
| Wound dehiscence| 13 (21%)  | 4 (100%)|
| Total          | 62 (100%) | 4 (100%) |

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 (20%) 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 risk factor for postoperative complications in major abdominal surgery<sup>[1]</sup>. The reported prevalence of malnutrition in gastrointestinal surgery patients ranges from 30% to 50%.<sup>[3,10]</sup> Kuzu et al.<sup>[11]</sup> reported that the level of malnourishment was directly correlated with both the severity and the frequency of postoperative complications. Beattie et al. suggested that perioperative nutritional support in malnourished patients decreased postoperative complications such as wound infections and sepsis.<sup>[14]</sup> It was reported that serum albumin on the 5th day after surgery was correlated with postoperative short-term complications<sup>[10]</sup>. 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.<sup>[17]</sup> suggested that malnutrition was an important risk factor for postoperative infections and wound complications.
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\(^\text{[11]}\). Many simple nutritional assessment or screening tools have been developed in recent years and have been validated\(^\text{[18]}\). 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\(^\text{[19]}\).

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/m\(^2\)] did not show a significantly higher incidence of postoperative complications\(^\text{[15]}\). Additionally, weight loss and hypoalbuminemia were not associated with an increased risk of mortality and morbidity in patients who underwent surgery for gastric cancer\(^\text{[5]}\). Some recent evidence suggested that overweight and obesity rather than malnutrition were significant risk factors for postoperative complications in major abdominal surgery\(^\text{[19]}\). With respect to wound complications, Shin et al\(^\text{[4]}\) reported that overweight (BMI > 25.0 kg/m\(^2\)) patients that underwent gastrectomy had a higher wound complication rate than normal body weight (BMI ≤ 25.0 kg/m\(^2\)) patients. Furthermore, Jabaiti 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\(^\text{[21]}\). In addition, Vastine et al\(^\text{[23]}\) reported that for abdominoplasties, 80% of obese patients had complications compared with the borderline and non-obese patients, and Hester et al\(^\text{[24]}\) 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\(^\text{[16]}\) found that in abdominoplasty, complications were significantly increased in patients with diabetes and/or hypertension, and Jabaiti\(^\text{[21]}\) 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.

**REFERENCES**

1. Central Cancer Registry in Korea. 2002 Annual report of the Central Cancer Registry in Korea. Seoul: Ministry of Health and Welfare, Republic of Korea, 2007.
2. Shin HR, Ahn YO, Bae JM, Shin MH, Lee DH, Lee CW, Ohrr HC, Ahn DH, Ferlay J, Parkin DM, Oh DK, Park JG. Cancer incidence in Korea. Cancer Res Treat 2002; 34: 405-408.
3. Schiesser M, Kirchhoff P, Müller MK, Schäfer M, Clavien PA. The correlation of nutrition risk index, nutrition risk score, and bioimpedance analysis with postoperative complications in patients undergoing gastrointestinal surgery. Surgery 2009; 145: 519-526.
4. Bozzetti F, Gianotti L, Braga M, Di Carlo V, Mariani L. Postoperative complications in gastrointestinal cancer patients: the joint role of the nutritional status and the nutritional support. Clin Nutr 2007; 26: 698-709.
5. Buzby GP, Willford PO, Peterson OL, Crosby LO, Page CP, Reinhardt GF, Mullen JL. A randomized clinical trial of total parenteral nutrition in malnourished surgical patients: the rationale and impact of previous clinical trials and pilot study on protocol design. Am J Clin Nutr 1988; 47: 357-365.
6. Cruse PJ, Foord R. The epidemiology of wound infection. A 10-year prospective study of 62,939 wounds. Surg Clin North Am 1980; 60: 27-40.
7. Kamat AA, Brancazio L, Gibson M. Wound infection in gynecologic surgery. Infect Dis Obstet Gynecol 2000; 8: 230-234.
8. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee.
Oh CA et al. NRI and postoperative wound complications

9 Chelmow D, Rodriguez EJ, Sabatini MM. Suture closure of subcutaneous fat and wound disruption after cesarean delivery: a meta-analysis. Obstet Gynecol 2004; 103: 974-980

10 Oh CA, Kim DH, Oh SJ, Choi MK, Noh JH, Sohn TS, Kim S, Bae JM. Changes of Preoperative and Postoperative Nutritional Status in Patients with Gastric Cancer and Assessment of Nutritional Factors correlated with short-term Postoperative Complications. J Korean Gastric Cancer Assoc 2010; 10: 5-12

11 Kuzu MA, Terzioglu H, Genç V, Erkek AB, Ozban M,Sonyurek P, Elhan AH, Torun N. Preoperative nutritional risk assessment in predicting postoperative outcome in patients undergoing major surgery. World J Surg 2006; 30: 378-390

12 Sungurtekin H, Sungurtekin U, Balci C, Zencir M, Erdem E. The influence of nutritional status on complications after major intraabdominal surgery. J Am Coll Nutr 2004; 23: 227-232

13 Buzby GP, Knox LS, Crosby LO, Eisenberg JM, Haakenson CM, McNeal GE, Page CP, Peterson OL, Reinhardt GF, Wil- liford WO. Study protocol: a randomized clinical trial of total parenteral nutrition in malnourished surgical patients. Ann J Clin Nutr 1988; 47: 366-381

14 Sano T, Kobori O, Muto T. Lymph node metastasis from early gastric cancer: endoscopic resection of tumour. Br J Surg 1992; 79: 241-244

15 Pacelli F, Bossola M, Rosa F, Tortorelli AP, Papa V, Dogliet- to GB. Is malnutrition still a risk factor of postoperative complications in gastric cancer surgery? Clin Nutr 2008; 27: 398-407

16 Beattie AH, Prach AT, Baxter JP, Pennington CR. A randomised controlled trial evaluating the use of enteral nutritional supplements postoperatively in malnourished surgical patients. Gut 2003; 46: 813-818

17 Gorman RC, Buzby GP. Perioperative nutritional interven- tions. In: SA Shikora, GL Blackburn, editors. Nutritional support: theory and therapeutics. New York: International Thomson Publishing, 1997: 91-112

18 Putwatana P, Reodecha P, Sirapo-ngam Y, Lertsithichai P, Sumboonnanonda K. Nutrition screening tools and the prediction of postoperative infectious and wound complications: comparison of methods in presence of risk adjust- ment. Nutrition 2005; 21: 691-697

19 Tsujinaka T, Sasako M, Yamamoto S, Sano T, Kurokawa Y, Nashimoto A, Kurita A, Kaita H, Shimizu T, Furukawa H, Inoue S, Hiratsuka M, Kinoshita T, Arai K, Yamamura Y. Influence of overweight on surgical complications for gastric cancer: results from a randomized control trial comparing D2 and extended para-aortic D3 lymphadenectomy (JCOG9501). Ann Surg Oncol 2007; 14: 355-361

20 Shin BS, Kim DY, Nam SH, Yook JH, Oh ST, Kim BS. Cor- relation of the body mass index with the rates of postopera- tive wound complications in gastric cancer patients. J Korean Gastric Cancer Assoc 2007; 7: 242-247

21 Jabaiti SK. Risk factors for wound complications following abdominoplasty. American Journal of Applied Sciences 2009; 6: 897-901

22 Vastine VL, Morgan RF, Williams GS, Gampper TJ, Drake DB, Knox LK, Lin KY. Wound complications of abdomino- plasty in obese patients. Ann Plast Surg 1999; 42: 34-39

23 Hester TR, Baird W, Bostwick J, Nahai F, Cukic J. Abdomino- plasty combined with other major surgical procedures: safe or sorry? Plast Reconstr Surg 1989; 83: 997-1004

24 Hensel JM, Lehman JA, Tantri MP, Parker MG, Wagner DS, Toppham NS. An outcomes analysis and satisfaction survey of 199 consecutive abdominoplasties. Ann Plast Surg 2001; 46: 357-363

S- Editor Sun H  L- Editor Cant MR  E- Editor Li JY