Original Article

Clinical application of the fast track surgery model based on preoperative nutritional risk screening in patients with esophageal cancer

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Objectives: To investigate the clinical application of the fast track surgery (FTS) model based on preoperative nutritional risk screening (NRS) in patients with esophageal cancer. **Methods:** 180 patients with esophageal cancer who underwent surgery between January 2008 and April 2014 were randomly divided into study and control groups based on matched-pairs. The study group underwent assessment using the NRS 2002 and received treatment before surgery and the control group was treated by the conventional method. Postoperative indicators including time to first exsufflation, time to defecation, time to chest tube removal, hospitalization duration, and postoperative complications were examined after surgery. **Results:** Compared with the control group, the postoperative indicators including time to first exsufflation (88.4±2.76 vs 57.83±2.68 hours), time to first defecation (4.68±1.71 vs 3.28±1.34 days), time to chest tube removal (4.30±0.25 vs 2.70±0.33 days), postoperative hospitalization durations (11.71±1.39 vs 9.00±0.78 days), and total complication rate (18.9% [17/90] vs 6.67% [6/90]) were all significantly reduced in the study group (p<0.05). **Conclusions:** The FTS model based on NRS can effectively promote postoperative rehabilitation of patients, reduce the incidence of postoperative complications, and shorten hospital stay.

Key Words: esophageal cancer, perioperation, nutrition risk screening, fast track surgery, postoperative indicator

INTRODUCTION

Esophageal cancer (EC) is a common type of gastrointestinal cancer. Surgery is the optimal treatment for patients with EC. Studies have shown that surgical stress and other complications are the main factors affecting the rehabilitation and quality of life of patients after surgery;[1] the nutritional status of patients with EC is closely related to postoperative complications.[2] Therefore, the incidence of surgery complications and postoperative hospitalization duration are high in EC patients.[3,4] Optimal management of perioperative surgical treatment for EC has become a research hotspot. In recent years, a new treatment model called fast track surgery (FTS) has been used with desired results.[5] This method combines anesthesiology, nutritional care, pain control, and surgical techniques that have been proven effective by evidence-based medicine for use in the preoperative, intraoperative, and postoperative period to reduce the incidence of surgical stress and complications and accelerate the postoperative rehabilitation of patients.[6,7] Treating EC patients with FTS can reduce postoperative complications and shorten hospital stay.[8] Studies have confirmed that nutritional status has an important influence on postoperative mortality and morbidity;[9] appropriate nutritional support for patients with malnutrition or at a risk for malnutrition can improve postoperative clinical outcomes.[10] Reports suggest that the use of clinical enteral nutrition (EN) is low, and a significant proportion of patients who use nutritional support do not need it, indicating that nutritional risk status is not assessed before administering nutritional support in clinical practice.[11,12] For this reason, the FTS model was used in the perioperative management of EC from January 2008 to April 2014 in our department, which included nutritional risk screening (NRS) using the NRS 2002 and intervention, and compared with conventional perioperative management. This study aimed to investigate the effectiveness and clinical significance of FTS.

MATERIALS AND METHODS
Patient information

Patients with pathologically confirmed EC who were eligible for radical surgical treatment as indicated by preoperative assessments were included in this study conducted between January 2008 and April 2014 at the Thoracic Surgery Department of East Affiliated Hospital of

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Tongji University. Patients diagnosed based on admission history, routine physical examination results, laboratory and laboratory-assisted examination results, and other procedures, underwent general assessment. One hundred and eighty hospitalized patients with EC who meet the inclusion criteria (no serious cardiovascular disease or liver and kidney dysfunction, hyperlipidemia, diabetes or other endocrine metabolic disorders, or hormone, radiotherapy, or chemotherapy treatment) were randomly divided into the study group and the control group (n=90) by the sealed envelope technique. Clinical data including age, gender, and tumor location and stage were not statistically different between groups (Table 1). Patients who could not complete treatment because of unwillingness to cooperate, unsuccessful epidural catheter placement, surgery duration >6 hours (hrs), intraoperative blood volume of 500 mL, unresectable tumor, complications after severe thoracic surgery (recurrent laryngeal nerve damage, phrenic nerve damage, respiratory failure, and pulmonary embolism) were excluded. The study was approved by the hospital ethics committee; the perioperative major operation of the two groups was completed by the same treatment group. This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Tongji University (#2008-012). Written informed consent was obtained from all participants.

Nutritional risk screening and assessment

The patients with EC in the study group underwent NRS using the unified NRS 2002 questionnaire within 24-48 hrs of admission.[10,13,14] Patients were fasted early in the morning before surgery, and their height and weight were measured wearing unlined clothes and no shoes (weight corrected to ±0.2 kg by RGZ120 type measuring meter and height corrected to ±0.5 cm). NRS involved a maximum score of 3 points for each aspect: impaired nutritional status and disease severity. For patients aged ≥70, 1 point was added to the above score, for a total score of 0-7 points. Patients with NRS score <3 points had no risk for malnutrition, and those with NRS ≥3 were at risk for malnutrition. Three variables (body indices, recent weight loss, and changes in eating habits) were used to assess malnutrition, and patients were classified based on the comprehensive results of the three variables.

Preoperative preparation

The study group was informed of the protocol of the FTS model before surgery. Patients with a NRS score of ≥3 points were included in the nutrition support program. Combined parenteral nutrition (PN) and EN were administered from the early preoperative stage (5-7 days) to support treatment. Patients did not fast the day before surgery, did not undergo coloclysis on the evening before surgery, or receive conventional indwelling stomach tube on the morning of surgery. Patients were administered 500 mL of EN emulsion (Fresubin) 12 hrs before surgery, and 300-500 mL of EN emulsion (5% glucose saline) 2 hrs before surgery.

The control group underwent conventional preoperative management, and no NRS was performed or targeted nutritional support administered. They could eat in the afternoon on the day before surgery, have liquid food in the night before surgery, undergo coloclysis in the evening before surgery and gastric tube or catheter placement in the morning of surgery, fast for 6 h before surgery, and could not drink water for 2 hrs before surgery.

Intraoperative treatment

The study group underwent general anesthesia and epidural anesthesia at T6-T8. Before induction of anesthesia, 10 mg of dexamethasone and short-acting propofol and remifentanil were administered as sedative and analgesic drugs. Surgery was performed immediately after successful anesthesia; the anesthesia time was minimized as much as possible. Intraoperatively, the infusion rate was controlled at a fluid volume of ≤1500 mL (500 mL of colloid with 1000 mL of balanced salt solution), and vasoactive drugs such as dopamine and the β-blocker esmolol were used based on heart rate and blood pressure. The infusion liquid was heated using the infusion warmer and other methods to maintain the patients' body temperature at approximately 36°C during surgery. The damage control surgical approach was used, which is the integrated use of a small minimally invasive incision and bloodless technologies without compromising the quality and speed, and ensuring maximal tumor resection. Intraoperative single-lumen endotracheal intubation, two-lung ventilation while avoiding pinching of lung tissue, placement of duodenal feeding tube used in conventional nasal surgery, and neck esophagus-stomach mechanical gastric anastomosis were performed.

In the control group, general anesthesia was administered, the volume of fluid was not controlled, no insulation measures were taken, and dexamethasone was not used. The incision length and the use of double-lumen endotracheal intubation and one-lung ventilation without enteral feeding tube placement were decided by the surgeon.

Postoperative treatment

The study group patients began physical activity in bed on the day of surgery, and were allowed to stand bedside the bed with little movement 1 day after surgery. The optimized nutritional support program involving PN and EN administered to control the fluid profile included the following: EN infusion through a nasojejunal feeding tube immediately after surgery (5% glucose and/or 200-500 mL Fresubin) with the dose tapered to 20 mL/h at 6 hrs after surgery; dose increased to nearly 1000 mL depending on patient tolerance at 36-48 hrs after surgery; and dose further increased to >1000 mL at 72 hrs after surgery (500 mL 5% glucose saline+200-400 mL REpower or 500 mL Fresubin+20-40 mL 10% oral KCl). The volume of intravenous fluids was correspondingly decreased. The stomach tube was disconnected after exsufflation, and the patients were fed a liquid diet (rice+soup+broth+juice). The feeding tube was removed after the patients could consume approximately 2000-2500 mL of the liquid diet, after which they were gradually fed a semi-liquid diet, followed by a normal diet. If the volume of fluid drained from the chest was <200 mL/day, lung function was good, and plasma protein levels were within the normal range, the chest tube was removed. Postoperative placement of

Table 1. Comparison of general information in the patients of the two groups (n=90)

Groups	Gender		Age		Lesion site		Anastomotic site		Tumor stage	
	Men	Women	≥60	<60	Middle	Lower	Neck/ stomach	Cupula pleurae	II	III
Study group	61	29	49	41	51	39	23	67	56	34
Control group	59	31	54	36	53	37	25	65	53	37
χ^2 value	0.176		0.221		0.029		0.177		0.218	
p value	0.971		0.823		0.825		0.952		0.779	

Table 2. Comparisons of operative time and postoperative situations in the two groups (mean±SD, n=90)

Groups	Operative time (h)	First flatus time (h)	First defecation time (d)	Tube extubation (d)	Postoperative hospital stay (d)	Incidence of complications, % (cases)
Study group	2.54±0.22	57.8±2.68	3.28±1.34	2.70±0.33	9.00±0.78	6.67 (6/90)
Control group	2.49±0.23	88.4±2.76	4.68±1.71	4.30±0.25	11.7±1.39	18.9 (17/90)
t	1.17	-54.6	-12.3	-25.8	-13.51	/
p	0.237	<0.0001	0.007	<0.0001	<0.0001	0.018

an epidural catheter was performed for continuous infusion of the analgesic acesodyne for 48 hrs (15 mL 100 g/L ropivacaine+0.05 mg sufentanil+85 mL saline).

The control group performed activities in bed before drainage tube removal, and out of bed after removal. The indications for removal of the chest drainage tube were drainage volume <100 mL/day, and good lung function on chest radiography. Postoperative nutrition included PN (500 mL 10% glucose+1440 mL Calvin injection+100 mL alanyl glutamine injection+250 mL 10% fat milk+500 mL 8.5% compound amino acid injection+500 mL hetastarch). In patients with no anastomotic fistula on esophagography on postoperative day 7, the stomach tube was disconnected to allow liquid diet consumption. On postoperative day 10, the nasojejunal feeding tube was removed and a semi-liquid diet was started.

Indicator assessment

The time to first exsufflation and defecation (daily bowel sounds on auscultation), time to chest tube removal, postoperative hospitalization duration, and postoperative complications (anastomotic leak, pulmonary infection, arrhythmia, and others) were recorded.

The recovery of gastrointestinal function was observed, including the duration of bloating and diarrhea, and the incidence of nausea, vomiting, and other gastrointestinal symptoms.

Indications for discharge included the following: recovery of gastrointestinal function (oral liquid or semi-liquid diet without intravenous infusion); activity out of bed without decompression or drainage catheters; and normal body temperature. Chest incision pain was controlled using oral analgesics. Patients were discharged if they met these criteria and if they were willing to continue rehabilitation at home.

Statistical methods

The SPSS13.0 software package was used for statistical analysis. Data were compared between groups using the independent sample t test. Comparisons of enumeration data were performed using the χ^2 test. The significance level was set at α=0.05.

RESULTS

The patients received transfusion of nutrients perioperatively, and underwent extubation postoperatively. No patient needed reintubation for ventilator use after admission to the intensive care unit. Based on the NRS 2002 questionnaire results, 47 patients in the study group had no preoperative risk for malnutrition (NRS score <3 points; 52.2%), 31 had risk for malnutrition (NRS score ≥3; 34.4%), and 12 had risk for undernourishment (13.3 %).

Compared with the control group, the FTS model based on intervention after NRS significantly decreased the drainage tube indwelling time and hospital stay in the study group patients, and the postoperative recovery of bowel function was significantly better in the study group than in the control group (p<0.01). The rate of postoperative complications in the study group was 6.7%, including l case of wound infection, 2 cases of arrhythmia, l case of pleural effusion, and 2 cases of pulmonary infection. The rate of postoperative complications in the control group was 18.9%, including 7 cases of lung infection, 4 cases of heart failure, 2 cases of wound infection, 1 case of anastomotic bleeding, 2 cases of pleural effusion, and l case of deep vein thrombosis. The difference in the postoperative complication rate was statistically significant between the two groups (χ^2=7.27, p=0.018; Table 2).

DISCUSSION

Currently, EC is one of the most common malignancies treated mainly by surgery. Due to the distinct anatomical structures, important physiological functions, and long-time eating disorders and cancer duration, patients with EC had varying degrees of malnutrition and immune suppression.[15] In addition to severe surgical trauma and long postoperative fasting, hospitalized patients with EC have a long hospital stay, poor prognosis, increased rate of complications, and slow recovery. Multivariate analysis showed that malnutrition or nutritional insufficiency were independent risk factors for postoperative infectious complications, mortality, and increased length of stay and hospital costs in adult patients and cancer patients hospitalized for surgery.[16] Nutritional support for EC patients

has become an important part of integrated multidisciplinary treatment. In the clinical practice of holistic integrated medicine, the FTS model uses a series of evidence-based medicine optimization measures in the perioperative period involving most recent concepts and technical integration, with the aim to reduce the stress response, promote functional recovery of the body,[17,18] and reduce the incidence of complications,[19] which accelerate the postoperative rehabilitation of patients, shorten postoperative hospital stay, and improve other clinical outcomes.[20] Studies on the use of FTS in EC patients are limited. We referred to domestic and foreign professional FTS programs while particularly considering esophageal surgery to develop an FTS model applicable to EC. The stringent clinical protocol was used to ensure reduction in fasting duration before surgery, relative selection of infusion volume, optimization of anesthesia and postoperative analgesia, damage control surgery technique, maintenance of body temperature during surgery, early activity and diet after surgery, early postoperative removal of catheters, and other comprehensive perioperative measures. Nutrition screening, assessment, and intervention were particularly important in the EC patients of the study group. For patients with risk for malnutrition, individualized nutritional support programs in line with the principles was formulated, and preoperative PN/EN treatment strategies to improve patient tolerance for surgery were optimized. The results showed reduced time to exsufflation and defecation, shortened hospital stay shortened, and reduced postoperative complication rate in patients who received FTS-based treatment. In addition, thoracotomy using a small surgical incision relatively reduced the use of disposable supplies and medical costs compared with laparoscopic surgery.

A number of studies reported a relationship between the risk for malnutrition and clinical outcomes, the results showed that the complication and mortality rates, hospital stay duration, and hospital costs of patients at risk for malnutrition increased compared with those of patients at no risk for malnutrition.[11,21,22] Therefore, nutritional status screening and assessment should be performed for patients undergoing surgery. The screening criteria NRS 2002, recommended by the European Society of Parenteral and Enteral Nutrition,[13] has many advantages for assessing the risk for malnutrition with respect to age, nutritional status, and disease severity compared with other forecasting tools, and has the most basis in evidence-based medicine. EC was considered the malignancy associated with the highest risk for malnutrition, although studies on hospitalized patients with EC are lacking. Nutritional assessment can ensure identification of patients for nutritional support and timely diagnosis of malnutrition or risk for malnutrition. A clinical nutrition support team including physicians, nurses, dietitians, and clinical pharmacists was used in one study. The NRS 2002 criteria were used to investigate the risk for malnutrition or presence of malnutrition. Patients with malnutrition or risk for malnutrition were administered preventive preoperative clinical nutrition (PN/EN) support before surgery,[23] and the clinical protocol for the surgical treatment of EC was then optimized. Jie have shown that in selected patients with risk for malnutrition, the overall

and infectious complication rates in patients who were administered nutritional support significantly improved compared with those in patients who did not receive nutritional support[12]. The incidence of complications in patients with no risk for malnutrition, determined by the NRS 2002, did not increase without PN or EN, and medical costs did not increase. In this study, the NRS 2002 was used for the preoperative screening of EC patients which revealed 34.4% at risk for malnutrition (NRS score ≥3) was, and 13.3% at risk for inadequate nutrition.

It has been confirmed that a higher proportion of patients had a preoperative NRS score of ≥3 points, and patients with a risk for malnutrition were more prone to postoperative complications.[11] Therefore, based on previous studies[24,25] and the combination of general conditions and clinical characteristics of the patients with EC, patients at risk for malnutrition (NRS score ≥3 points) were directly administered the optimized nutritional support and included in the FTS model, with EN administered to maintain intestinal barrier function and PN administered to avoid malnutrition and infection due to long-term insufficient feeding, which helped improve clinical outcomes in these patients. Furthermore, the FTS model based on NRS emphasized early postoperative EN (EEN), helped determine the postoperative start time for eating and dose of enteral nutrition, provided nutrition through the nose–duodenal feeding tube directly through the digestive tract, promoted bowel movements and intestinal epithelial hyperplasia, enabled repair and maintenance of mucosal barrier function, and prevented long-duration fasting that causes intestinal mucosal barrier damage and normal flora dysfunction.[26] Nasal feeding of liquid and EN early after surgery allows control of intravenous fluid volume and reduces cardiovascular burden, which was also in line with the principle of fluid control in FTS philosophy.[27,28] In addition, this study results showed that the reduction in the intravenous fluid volume and early removal of tubes to create favorable conditions for early postoperative activity reduced blood stasis and thrombosis caused by long-time immobility, and reduced the incidence of atelectasis and pulmonary infection.[29] Our data showed that along with the use of the FTS model for routine perioperative management of the surgical treatment of EC, clinical measures such as nutrition risk screening, assessment, and intervention are important. It needs to be emphasized that at the time of selection, the patients in this study were relatively healthy patients undergoing EC surgery. Randomized controlled studies and evidence-based research are needed in patients who do not meet these criteria. Improved and perfected techniques are needed to refine the surgical treatment of EC.

AUTHOR DISCLOSURES
All authors have no conflict of interest regarding this paper.

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Original Article

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基于营养风险筛查的快速康复外科在食管癌围手术期中的应用

目的：探讨基于营养风险筛查（nutritional risk screening, NRS）的快速康复外科（fast track surgery, FTS）模式在食管癌患者围手术期治疗中的临床应用。方法：选取2008年01月至2014年04月同期住院食管鳞癌适宜手术治疗的患者180例随机分为两组（n=90）：研究组术前采用营养风险筛查2002 （NRS2002）方法进行评估并予以干预性治疗；对照组按传统围手术期方法（conventional perioperative management）治疗。观察两组病例术后首次排气、排便时间、拔除胸腔引流管时间、术后住院时间以及手术并发症等情况。结果：两组手术时间差异无统计学意义（*p*>0.05）。与对照组比较，研究组术后首次排气时间[88.4±2.76 h vs 57.8±2.68 h]、首次排便时间[4.68±1.71 d *vs* 3.28±1.34 d]、拔除胸腔引流管时间[4.30±0.25 d vs 2.70±0.33 d]、术后住院时间[11.7±1.39 d vs 9.00±0.78 d]以及总并发症发生率[18.9%（17/90）vs 6.67%（6/90）]等均显著减少，其差异具有统计学意义（*p*<0.05）。 结论：应用基于营养风险筛查的FTS模式，可有效促进食管癌患者术后的康复，减少术后并发症的发生率，缩短住院时间，从而改善患者的临床疗效。

关键词：食管肿瘤、围手术期、营养风险筛查、快速康复外科、术后指标