Original Article

Perioperative nutrition management in patients with spinal tuberculosis taking ERAS measures

Jiaojie Ma MS[1†], Zhuo Li MS[1†], Yang Chen MS[1], Yachao Zhang BS[2], Qian Wang BS[2], Guangxuan Yan MS[2], Weijie Dong MS[2], Shanshan Li PhD[3]

[1]Department of Clinical Nutrition, Beijing Chest Hospital Affiliated to Capital Medical University, Beijing, China
[2]Orthopedics Department, Beijing Chest Hospital Affiliated to Capital Medical University, Beijing, China
[3]Department of Bacteriology and Immunology, Beijing Key Laboratory on Drug-Resistant Tuberculosis Research, Beijing Chest Hospital Affiliated to Capital Medical University, Beijing, China
[†]Both authors contributed equally to this manuscript

Background and Objectives: To explore the effect of nutrition management under ERAS concept in patients with spinal tuberculosis. **Methods and Study Design:** The study was conducted in an orthopedic ward of a tertiary grade A special hospital in Beijing. The patients admitted from January 1, 2021 to June 27, 2023 were screened for inclusion. The qualified patients were randomized into experimental group or control group. The experimental group received perioperative nutrition management under the concept of ERAS while the control group received routine perioperative management in hospital. The data was collected on the next day of admission, the next day and the sixth day after operation, including laboratory indicators (lymphocyte count, hemoglobin level, etc), intraoperative bleeding volume, postoperative exhaust, defecation time, drainage volume, albumin infusion amount, nutritional risk score, length of stay, hospitalization costs, etc. Univariate analysis and multivariate analysis correcting for gender, age, and baseline values were performed using SPSS24.0. **Results:** A total of 127 patients with spinal tuberculosis completed the study. Compared with the control group, the intraoperative blood loss (p=0.028) in the experimental group was significantly reduced, the postoperative exhaust time (p=0.012) and defecation time (p=0.012) were significantly shortened, and the nutritional status (p<0.001) was significantly improved. Besides, the results of multivariate analysis are robust after correcting potential confounding factors. **Conclusions:** Nutrition management under the concept of ERAS is helpful to reduce intraoperative bleeding, promote postoperative flatus and defecation, and improve nutritional status in patients with spinal tuberculosis, which may further improve their clinical outcome and prognosis.

Key Words: spinal tuberculosis, accelerated rehabilitation surgery, nutrition management, randomized controlled trial, perioperative period

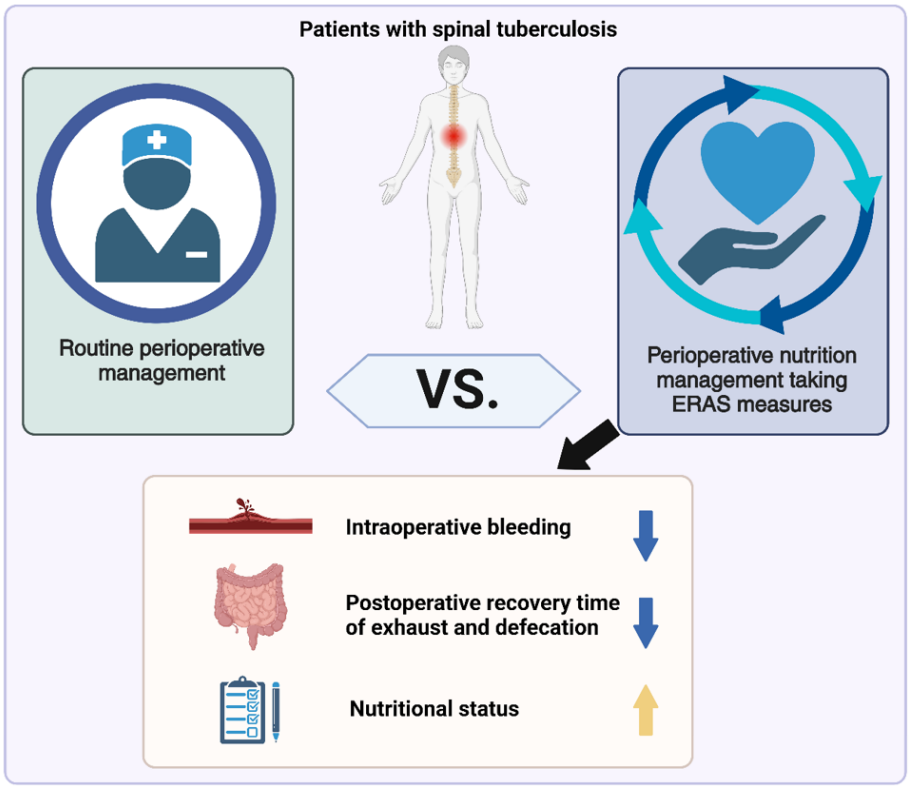
INTRODUCTION

As one of the fatal diseases in the world, tuberculosis is a serious threat to human health.[1] According to the lesion site, tuberculosis is divided into pulmonary tuberculosis and extrapulmonary tuberculosis (including lymph node nuclei, tuberculous meningitis, intestinal tuberculosis, bone tuberculosis, etc.). Among them, spinal tuberculosis is an extrapulmonary tuberculosis caused by secondary infection of *Mycobacterium tuberculosis* in the spine and its adnexal tissues. Spinal tuberculosis accounts for nearly 2% of all tuberculosis cases and about 50% of bone tuberculosis cases. Worldwide, the annual incidence of spinal tuberculosis exceeds 100,000. Spinal tuberculosis can cause vertebral bone destruction, collapse and fracture, compression of the spinal cord, and even lead to paraplegia and other serious adverse outcomes.

At present, surgery is the main treatment for spinal tuberculosis in clinical practice, including abscess drainage, lesion removal, and fusion internal fixation, in order to rebuild spinal stability. However, due to the problems such as long treatment time and slow postoperative rehabilitation, the treatment for the patients with spinal tuberculosis still faces a huge challenge.[2]

The concept of enhanced recovery after surgery (ERAS) is a series of optimization measures during the operation based on evidence-based medicine to reduce the physiological and psychological related traumatic stress during the perioperative period, thereby reducing the related complications and shortening the hospitalization duration, achieving the purpose of accelerated rehabilitation.[3] The concept and technology of ERAS have been extended to the perioperative management of spine sur-

Corresponding Author: Dr Shanshan Li, Department of Bacteriology and Immunology, Beijing Key Laboratory on Drug-Resistant Tuberculosis Research, Beijing Chest Hospital Affiliated to Capital Medical University, Beijing 11149, China
Tel: 010-89509484
Email: lss9011@126.com
Manuscript received 09 December 2023. Initial review completed 28 December 2023. Revision accepted 23 January 2024.
doi: 10.6133/apjcn.202403_33(1).0005



Graphical abstract

gery, and an expert consensus has been published.[4] However, the application of ERAS in spinal tuberculosis surgery is still in the exploratory phase. In ERAS management, nutrition management should run through the whole perioperative period.

The symptoms such as fever, anorexia, abscess, pain, etc, are common among patients with spinal tuberculosis, and further cause reduced nutrition intake, gastrointestinal digestion and absorption dysfunction and increased consumption of nutrients, finally resulting in decreased nutritional status. Studies have shown that the prevalence of nutritional risk in patients with spinal tuberculosis at the time of admission and on the sixth postoperative day are 36.4% and 87.9%, respectively.[5] Thus, the nutritional problems of patients with spinal tuberculosis are more prominent.

Clinical outcomes in patients with spinal tuberculosis are associated with a variety of factors, of which tuberculosis control and nutritional status are two key factors. Studies have shown that, rational nutrition management during perioperative period helps to improve the clinical outcome of patients with spinal tuberculosis.[6]

The aim of this study was to explore the clinical application and effects of nutrition management under the concept of ERAS in patients with spinal tuberculosis, so as to provide some references for further promotion of ERAS in clinical practice among patients with spinal tuberculosis.

METHODS

This study was a prospective randomized, open-label, interventional study approved by the Ethics Committee of Beijing Chest Hospital Affiliated to Capital Medical University [Year (2021)–Scientific Research–Temporary Examination No.02]. And it conformed to the provisions of the Declaration of Helsinki in 1995.

Participants

The research site was an orthopedic ward of a tertiary grade A special hospital in Beijing. A cluster sampling was used to continuously include the patients who were admitted from January 1, 2021 to June 27, 2023 and met the following inclusion and exclusion criteria.

Inclusion criteria: (1) age 18–60 years old; (2) patients with spinal tuberculosis undergoing elective surgery; (3) Sign informed consent form.

Exclusion criteria: (1) Patients with serious diseases other than spinal tuberculosis, including any uncontrolled and clinically significant heart disease, lung disease, liver and kidney disease, nervous system disease, immune disease or malignant tumor; (2) Patients with diabetes or fructose metabolism defects; (3) Patients with digestive abnormalities such as delayed gastric emptying, gastroesophageal reflux, abnormal gastrointestinal peristalsis, and gastrointestinal obstruction; (4) Patients have the history of alcohol and drug abuse.

Exit criteria: (1) Subjects voluntarily withdrew; (2) The researcher makes a decision after evaluation (the treatment course is not completed according to the protocol, and other nutritional preparations which may affect the efficacy observation are applied or the data are incomplete); (3) The condition deteriorates or serious adverse events occurs.

Randomization and intervention

According to the random number table, participants who met the inclusion and exclusion criteria were randomly divided into the experimental group and the control

group. The experimental group received perioperative nutrition management under the concept of ERAS, while the control group received routine perioperative management in hospital. According to the relevant expert consensus,[7] and in combination with the experience of researchers, the intervention plan was designed.

Specifically, the experimental group was deprived of food and water for 6h and 2h, respectively, and 12.5% carbohydrates (400mL and 200mL) were given at 10h and 2h before surgery, respectively. On the day of surgery, water (20mL) was given after patients awaked from anesthesia, then, water (40ml) and synbiotics (10g) were given at 4h after surgery, and short peptide type nutritional preparation (40g, energy 816kJ, protein 9g, fat 0.95g, and carbohydrate 37.6 g) was given at 6h after surgery. From the next day to the 3rd day after surgery, synbiotics 20g/ day (10g/ time, twice a day) and whole protein type nutritional preparation 150g/ day (50g/ time, three times a day, energy 2658kJ, protein 37.5g, fat 24.8g, and carbohydrate 60 g) were administered. The above-mentioned whole protein type nutritional preparations were continuously administered from the 4th to the 7th postoperative day.

The control group was deprived of food and water for 12h and 8h, respectively. And water intake and fluid diet were started in the morning on the next day after surgery, and experienced the transition to the normal diet gradually. From the next day to the 7th day after surgery, the corresponding nutritional preparations were routinely given according to the nutritional status in hospital. See Table 1 and Figure 1 for details.

Outcome measures and blind method

The primary outcome measure of this study was postoperative defecation time, and secondary outcome measures included postoperative exhaust time, drainage volume, white blood cell (WBC) count, red blood cell (RBC) count, lymphocyte (LY) count, hemoglobin (HGB) level, albumin (ALB) level, total protein (TP) level, fasting blood glucose (GLU) level, C-reactive protein (CRP) level, intraoperative bleeding volume, albumin transfusion amount, nutritional risk score, length of stay (LOS), and hospitalization cost.

In which, postoperative exhaust, defecation time, and

Table 1. Nutrition management implementation procedure of the study

Group	The day before surgery	Day of surgery	The next day to 7 days after surgery
EP	1.deprived of food (6h) and water (2h); 2.have 12.5% carbohydrates drinks at 10h (400mL) and 2h (200mL) before surgery, respectively.	1.have water (20mL) after awaking from anesthesia; 2.have water (40mL) and synbiotics (10g) at 4h after surgery; 3.have short peptide type nutritional preparation (40g, energy 816kJ, protein 9g, fat 0.95g, and carbohydrate 37.6 g) at 6h after surgery; 4.restart oral diet gradually.	1.have synbiotics 20g/ day (10g/ time, twice a day) from the next day to the 3rd day after surgery; 2.have the whole protein type nutritional preparation 150g/ day (50g/ time, three times a day, energy 2658kJ, protein 37.5g, fat 24.75g, and carbohydrate 60 g) from the next day to the 7th day after surgery.
CP	1.deprived of food (12h) and water (8h).	1.have water and fluid diet in the morning on the next day after surgery; 2.transition to the normal diet gradually.	1.have the corresponding nutritional preparations according to the nutritional status in hospital routine.

EP, experimental group; CP, control group.

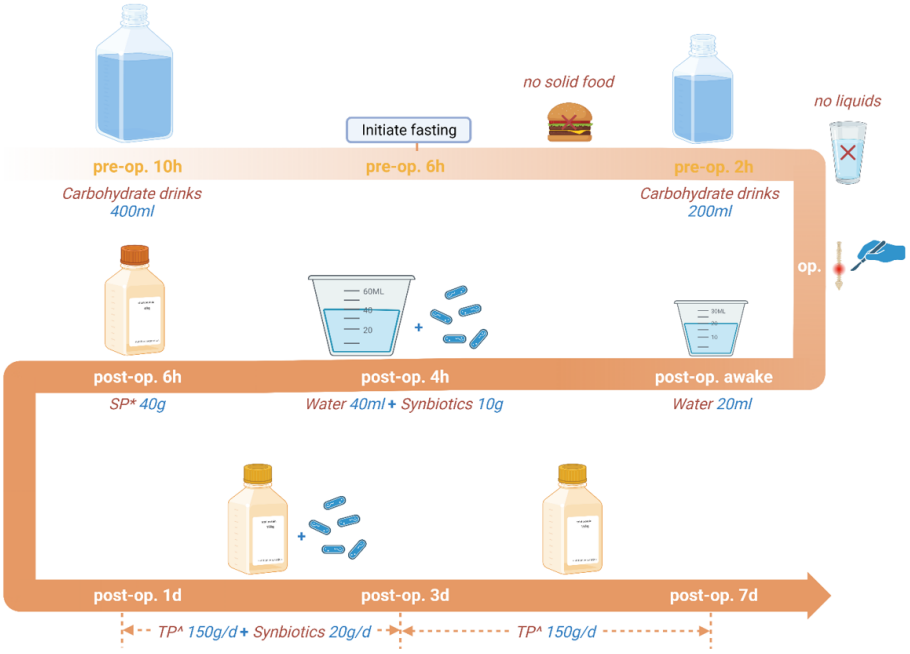


Figure 1. Perioperative nutrition management taking ERAS measures in experimental group (EP)

drainage were obtained from the nursing records. Laboratory indicators such as WBC, RBC, LY, HGB, ALB, TP, GLU and CRP were obtained through fasting venous blood collection on the next day of hospital admission, the next day after surgery or the morning of the 6th day after surgery. The intraoperative bleeding volume and albumin transfusion amount were obtained from the corresponding surgical records. The nutritional risk score was obtained after screening procedure completed by the researchers. LOS, hospitalization costs were obtained from the discharge records.

The above nutritional screening was performed by researchers using an evidence-based nutritional screening tool, Nutrition Risk Screening 2002 (NRS2002).[8,9] NRS2002 included nutritional status score, disease severity score and age score (add 1 point if the patient is over 70 years old). If NRS2002 score ≥3 points, the patient was at nutritional risk.

Patients, doctors, nurses, and the investigator who collected the data were not blinded in this study, and the person performing the data analysis was not aware of the grouping.

Statistics

Sample size calculation

Based on the exhaust time as the basis of sample size calculation and with reference to the data from the preliminary test (the average exhaust times of the experimental group and the control group were 25.5h and 30.7h), α=0.05 and β=0.1 were taken, and the sample size N=108 was calculated by using the sample size calculation software PASS. Considering that the loss of follow-up rate was not more than 20%, the final sample size was 135.

Statistical analysis

SPSS 24.0 software was used for data entry and statistical analysis. The data conforming to the normal distribution was described as "mean standard deviation", and the t test was used to test the difference between two groups. The non-normal distribution was described as "median (quartile) [M(Q1, Q3)]", and the difference between the two groups was examined by rank-sum test. Enumeration data was described as "percentage or constituent ratio (%)", and the difference between two groups was compared by Chi-square test. p<0.05 indicated that the difference was statistically significant.

RESULTS

A total of 137 subjects were finally included in the study, and 10 patients withdrew from the study midway. The specific reasons are shown in Table 2. Finally, data from 127 subjects were included in the statistical analysis. The ages of the participants in the experimental group and the control group were 39.7±12.5 years old and 40.7±13.0 years old, respectively; the proportions of men were 46.8% and 60%, respectively; the BMI was 22.6±3.2 kg/m^2 and 23.0±3.8 kg/m^2, respectively. In addition, the clinical characteristics of the two groups, such as concomitant pulmonary tuberculosis, fever, initial/retreatment, NRS2002 score, WBC, RBC and other laboratory indicators, were balanced and comparable, as shown in Table 3. What's more, all patients with spinal tuberculosis included in this study had the same surgical grading (Grade IV) and the same surgeon.

The results of univariate analysis showed that, compared with the control group, the experimental group's intraoperative bleeding volume was significantly reduced (p=0.028), exhaust time (p=0.012) and defecation time (p=0.012) were significantly shortened, and the proportion without nutritional risk (that is, NRS2002 score < 3) was significantly increased (p<0.001). In addition, compared with the control group, the CRP level on the next day after surgery, drainage volume and LOS in the experimental group tended to decrease, but the differences did not reach statistical significance. See Table 4.

Considering that gender and age might be potential confounding factors, and gender distribution was not balanced between the two groups, multivariate analysis was performed after correcting for gender and age factors. The results showed that significant differences still existed in the intraoperative bleeding volume (p=0.033), exhaust time (p=0.016), defecation time (p=0.016) and NRS2002 scores (p<0.001) between the experimental group and the control group, as shown in Table 5.

DISCUSSION

This is a prospective randomized controlled study comparing the impact of perioperative nutrition management under the ERAS concept with routine perioperative management in hospital on the clinical outcomes of patients with spinal tuberculosis.

Table 2. Reasons for withdrawal of participants

Number of cases	Reasons for withdrawal
1	Preoperative compliance was poor and 12.5% carbohydrate drinks were not supplemented.
2	Abdominal distension was obvious after taking nutritional preparations after surgery, and they refused to continue to participate in the study or did not follow the study protocol.
4	nausea and stomach discomfort after taking nutritional preparations after surgery and refused to continue to participate in the study.
2	Diarrhea occurred after surgery, and synbiotics and nutritional preparations were not taken according to the study protocol
1	Strong anaesthesia related discomfort, refusal to take nutritional preparations

EP, experimental group; CP, control group; WBC, white blood cell; RBC, red blood cell; LY, lymphocyte; HGB, hemoglobin; ALB, albumin; TP, total protein; GLU, fasting blood glucose; CRP, C-reactive protein; length of stay (LOS).
†6th day after surgery, ‡the next day after surgery.

Table 3. Sociodemographic characteristics and laboratory indicators at baseline†

Indicators	EP	CP
Sex		
male	29	39
female	33	26
Age [M(Q1, Q3)](years)	39.7±12.5	40.7±13.0
BMI (kg/m^2)	22.6±3.2	23.0±3.8
Combined pulmonary tuberculosis		
yes	21	23
no	41	42
fever		
yes	18	18
no	44	47
Initial/retreatment		
initial treatment	57	63
retreatment	5	2
WBC [M(Q1, Q3)](10^9/L)	6.1±1.8	6.2±2.0
RBC (10^12/L)	4.4±0.5	4.5±0.5
LY (10^9/L)	1.5±0.6	1.4±0.5
HGB (g/L)	123±17.0	125±17.2
TP (g/L)	70.1±5.6	69.9±5.9
ALB (g/L)	39.8±4.3	39.6±3.8
GLU [M(Q1, Q3)](mmol/L)	4.8±0.5	5.0±0.7
NRS2002 score		
≥3 points	31	33
<3 points	31	32

EP, experimental group; CP, control group; WBC, white blood cell; RBC, red blood cell; LY, lymphocyte; HGB, hemoglobin; ALB, albumin; TP, total protein; GLU, fasting blood glucose; CRP, C-reactive protein.
†Only 5 people had drug-resistant TB and was not listed in the table above.

Table 4. Univariate analysis of outcome indicators in the study

Indicators	EP	CP	Test statistics (T/Z/X^2)	*p* value
WBC† (10^9/L)	6.78±2.55	7.14±2.56	0.803	0.424
RBC† (10^{12}/L)	3.45±0.53	3.48±0.58	0.351	0.726
LY† (10^9/L)	1.14±0.47	1.09±0.41	-0.624	0.534
HGB† (g/L)	98.2±15.5	98.1±17.3	-0.034	0.973
TP† (g/L)	60.0±5.7	58.6±5.4	-1.357	0.177
ALB† (g/L)	32.8±4.1	32.1±3.2	-1.015	0.312
GLU‡ (mmol/L)	6.01±1.21	6.11±1.41	0.459	0.647
CRP‡ (mg/L)	51.6±32.8	56.0±33.0	0.759	0.449
Intraoperative bleeding volume (mL)	300 (200, 500)	400 (200, 600)	-2.201	0.028
Drainage volume (mL)	621 (443, 994)	690 (475, 1013)	-1.10	0.271
LOS (days)	25.2±7.0	23.5±8.0	-1.245	0.215
Hospitalization cost (ten thousand yuan)	11.8 (10.3, 13.0)	11.5 (9.7, 13.4)	-0.207	0.836
Albumin transfusion				
yes	16	21	0.650	0.420
no	46	44		
Postoperative exhaust time (h)	24.5 (15.0, 38.5)	30.0 (21.0, 49.3)	-2.502	0.012
Postoperative defecation time (h)	93.0 (58.4, 123.3)	113.0 (76.5, 147.0)	-2.501	0.012
NRS2002 scores at 6th day after surgery			13.893	<0.001
≥3 points	50	65		
<3 points	12	0		

EP, experimental group; CP, control group; WBC, white blood cell; RBC, red blood cell; LY, lymphocyte; HGB, hemoglobin; ALB, albumin; TP, total protein; GLU, fasting blood glucose; CRP, C-reactive protein; length of stay (LOS).
†6th day after surgery, ‡the next day after surgery

Nutritional status

Due to the infection of mycobacterium tuberculosis, patients with spinal tuberculosis often suffer from fever, decreased appetite and increased inflammatory response in the body, resulting in decreased food intake, increased consumption of nutrients and decreased gastrointestinal digestion and absorption, and further leading to poor nutritional status.

The results of this study indicate that approximately 50% of patients with spinal tuberculosis are at nutritional risk at the time of admission. And the nutritional status tend to be worse after surgery when they don't receive

Table 5. Multivariate analysis of outcome indicators in the study

Dependent variable	Unstandardized coefficients		Standardization coefficient	t	*p* value
	B	Standard error	Beta		
Intraoperative bleeding volume (mL)†	-102.824	47.674	-0.191	-2.157	0.033
Drainage volume (mL)	-186.678	114.496	-0.147	-1.630	0.106
Albumin transfusion amount (g)†	0.731	3.697	0.018	0.198	0.844
Postoperative exhaust time (h)†	-8.192	3.351	-0.213	-2.445	0.016
Postoperative defecation time (h)†	-21.045	8.585	-0.216	-2.451	0.016
WBC (10^9/L)‡§	-0.222	0.402	-0.044	-0.553	0.582
RBC (10^{12}/L)‡§	0.044	0.085	0.040	0.516	0.607
LY (10^9/L)‡§	0.029	0.054	0.033	0.531	0.596
TP (g/L)‡§	1.254	0.924	0.113	1.357	0.177
HGB (g/L)‡§	1.545	2.310	0.047	0.669	0.505
ALB (g/L)‡§	0.564	0.589	0.077	0.958	0.340
GLU (mmol/L)§¶	-0.006	0.211	-0.002	-0.028	0.977
CRP (mg/L)§¶	-2.496	5.759	-0.038	-0.433	0.665
NRS2002 scores§	-0.578	0.125	-0.357	-4.641	<0.001

†adjusting for sex, age
‡6th day after surgery
§adjusting for sex, age and corresponding baseline value
¶the next day after surgery

rational nutritional management during the perioperative period. According to the data from a study, the prevalence of nutritional risk in patients with spinal tuberculosis at one week after surgery is nearly 90%.[5]

Rational nutritional management of patients with spinal tuberculosis during the perioperative period can help to reduce the adverse effects of the operation on the body and maintain or even improve their nutritional status. The results of this study showed a significantly higher proportion of participants in the experimental group who had no nutritional risk at 6th day after surgery compared with controls (19.4% vs.0%, $p<0.001$). Therefore, perioperative nutrition management under the concept of ERAS is effective for improving the nutritional status of patients with spinal tuberculosis.

Nutritional management of patients has not been included in the routine perioperative management in our hospital. In the clinical pathway of ERAS, nutritional management should be throughout the perioperative period. Under the guidance of ERAS, patients who intend to undergo surgery for spinal tuberculosis should avoid long-term fasting before surgery, and oral feeding should be restarted as early as possible after surgery, and timely nutrition support therapy when necessary, so as to reduce the factors that exacerbate stress-related catabolism or impaired gastrointestinal function.[10]

Intraoperative bleeding volume, drainage volume

For patients with spinal tuberculosis undergoing surgical treatment, no matter which surgical approach is adopted, reducing intraoperative bleeding volume and postoperative drainage volume are the key factors for preventing patients from postoperative complications such as anemia and hypoproteinemia and accelerating patients' postoperative recovery.

The application of ERAS concept in perioperative period requires the multidisciplinary collaboration of surgery, anesthesia, nursing, and nutrition. Among them, the major factors affecting the intraoperative blood loss are the selection of surgical plan, the control of surgical duration, and the implementation of anesthesia plan. Results from a retrospective cohort study showed that ERAS management significantly reduced intraoperative bleeding (157 vs. 215 mL, $p=0.003$) in patients with surgically treated spinal metastatic tumors.[11] However, the ERAS embodiment of that study mainly covered preoperative patient education, intraoperative fluid management, analgesic drug use, early postoperative urinary catheter removal, encouragement of early ambulation and feeding, and did not include preoperative nutrition management.

Our study focused on nutrition management under the concept of ERAS, and the results showed that compared with the control group, the intraoperative blood loss of patients in the experimental group was significantly reduced, and the analysis results were consistent even after adjusting for potential confounding factors such as gender and age. In this study, the patients in the experimental group were deprived of food and water for a short period of time before operation. They were given 12.5% carbohydrate drinks before operation. This helped to relieve the physiological and psychological stress responses of patients due to hunger and fear, and thus reduced the amount of bleeding during the operation.

Studies have shown that there is a certain correlation between the amount of intraoperative bleeding and postoperative drainage.[12] The results of this study showed that, compared with the control group, the drainage volume of the experimental group had no significant difference, but it showed the decreased trend in the experimental group. The author analyzed that the postoperative drainage volume was affected by a variety of factors, such as the surgical method, the location of the drainage tube, and individual differences. In this study, potential influencing factors related to the drainage volume were not collected, which might cause certain confusion. In addition, in this study, the sample size was calculated with the exhaust time as the primary outcome indicator, which might not achieve the test efficiency of the difference in drainage volume between groups. Although the results of intraoperative bleeding volume and postopera-

tive drainage in this study are inconsistent, this study still provides clues for further research. In the future, we can conduct an expanded sample size study with intraoperative bleeding volume or drainage volume as the primary outcome indicator.

Exhaust and defecation time

Postoperative exhaust is one of the important indicators for judging the recovery of intestinal function. Early recovery of intestinal function can shorten the postoperative fasting time of patients, so as to initiate nutrition management measures such as oral diet and oral nutrition supplement as soon as possible, thus promoting the repair of gastrointestinal mucosa, and reduce the risk of intestinal adhesion, intestinal obstruction and other complications.[13,14]

The results of this study showed that early postoperative supplementation of a small amount of water, synbiotic and short peptide nutritional preparations could significantly shorten the exhaust and defecation time of patients with spinal tuberculosis. Therefore, nutrition management under the concept of ERAS helps to promote the recovery of gastrointestinal function in patients, which is of great significance for accelerating the postoperative rehabilitation of patients with spinal tuberculosis.

It should be noted that postoperative analgesic drugs commonly used in patients with spinal tuberculosis can significantly inhibit gastrointestinal peristalsis, thus affecting the exhaust and defecation time.[15] However, since the patients included in this study had the same surgical grade and the use of analgesic drugs was roughly the same between the two groups after randomization (not listed in the table), the results of this study were reliable.

Laboratory indicators

A large number of studies have shown that ERAS measures, including shortening the preoperative time of fasting and water deprivation, administration of a proper amount of water, early postoperative recovery of water inflow, food intake and other nutritional management measures, helps to reduce stress response in patients, thus contributing to the stability of postoperative blood glucose levels and CRP levels.[16,17]

The results of this study showed that there was no significant difference in fasting blood glucose levels and CRP levels on the next day after surgery between the experimental group and the control group. Further analysis showed that only one patient with spinal tuberculosis in this study was accompanied with abnormal glucose tolerance before operation. Over 80% of the patients with spinal tuberculosis had their blood glucose levels in the normal range on the next day after operation. In other words, the patients in the experimental group and the control group had good blood glucose regulation ability. To reflect the improvement effect of perioperative nutrition management on postoperative blood glucose, a certain proportion of patients with diabetes or impaired glucose tolerance should be included.

As for the research results of CRP, the author analyzed that although there was no significant difference between the two groups, CRP in the experimental group still showed a downward trend, suggesting that relevant research could be further conducted.

In addition, in this study, patients in the experimental group with spinal tuberculosis received continuous oral nutrition supplement from the next day to the 7th day after operation, in the hope of improving their energy and protein intake and promoting positive nitrogen balance, thereby reducing protein consumption and promoting wound healing. However, the results of the study showed that there was no significant difference in the levels of HGB, ALB and TP at 6th day after surgery between the experimental group and the control group. The potential causes were that HGB was affected by factors such as the amount of bleeding during the surgery, and indicators such as ALB mainly reflected the synthetic function of the liver (rather than the nutritional state), and its half-life was long.

Strengths and limitations

The clinical application of ERAS in patients with spinal tuberculosis is still rare, and the research evidence related to nutrition management under the concept of ERAS is even more insufficient. According to the retrieval, this study is currently the largest randomized controlled study in China focusing on nutrition management under the ERAS concept among spinal tuberculosis patients.18-20 In addition, the researchers ensured the good compliance of research subjects by strengthening follow-up. According to statistics, the loss of follow-up rate in this study was not more than 10%, which ensured the reliability of research results.

However, this study has certain limitations as well. First, nutrition management under the ERAS concept covers the entire perioperative period, while the preoperative nutrition intervention was not intensified for the patients with spinal tuberculosis in poor nutritional status in this study. The whole-course nutrition management model during the perioperative period can be further improved in future studies.

Second, the blind method was not adopted in this study, the compliance of the experimental group and the control group might be affected, thus resulting in potential bias. However, in fact, the follow-up records of this study showed that patients' compliance with nutrition management was good, so the non-use of blind method had little impact on the study results. Finally, the analysis results of outcome indicators such as drainage volume and hospitalization duration showed that the differences between groups were not significant. However, there were many factors influencing these outcome indicators. In the future, more detailed relevant data collection and appropriately expanded sample size should be conducted to eliminate the influence of potential confounding factors and reveal the role of nutrition management under the ERAS concept in these outcome indicators.

Conclusions

Nutritional management, as an important part of ERAS management, can significantly improve the perioperative nutritional status of patients with spinal tuberculosis, reduce the amount of bleeding during the operation, and promote the recovery of intestinal function of patients,

thereby accelerating the postoperative recovery. Therefore, the clinical application of nutrition management under the concept of ERAS in patients with spinal tuberculosis during the perioperative period should be promoted. Subsequently, relevant multi-center studies can be conducted to explore the impact of nutrition management under the ERAS concept on the long-term rehabilitation in patients with spinal tuberculosis.

ACKNOWLEDGEMENTS

We thank Hong He for excellent technical assistance and Guohua Lei for revising the manuscript. Special thanks go to participants for participating in our study.

CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors declare no conflict of interest.

Nanjing Yuheming Medical Nutrition Technology Co., Ltd. provided nutrition preparation and publishing fees, expert consulting fees, etc. Hainan Junkang Health Industry Co., Ltd. assisted in providing nutrition preparation. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

REFERENCES

1. Adam T, Baddeley A, Bastard M, Boon SD, Dean A, Falzon D, et al (The Global Tuberculosis Programme). World Health Organization Global tuberculosis report 2023. 2023/11/7 [cited 2023/11/26]; Available from: https://www.who.int/publications/i/item/9789240083851
2. Khanna K, Sabharwal S. Spinal tuberculosis: a comprehensive review for the modern spine surgeon. Spine J. 2019; 19: 1858-70. doi: 10.1016/j.spinee.2019.05.002.
3. Ljungqvist O, Scott M, Fearon KC. Enhanced recovery after surgery: a review. JAMA Surg. 2017; 152:292-8. doi:10.1001/jamasurg.2016.4952
4. Sun TS, Shen JX, Liu ZJ, Li CD, Hong Y, Sun CT, et al. Expert consensus in enhanced recovery after spinal surgery in China: perioperative management. Chinese Journal Bone and Joint Surgery. 2017; 10: 271-9. doi:10.3969/j.issn.2095-9958.2017.04-01. (in Chinese)
5. Lei GH, Ma JJ, Wang Q, Cao YH, Wang XH. The perioperative nutritional status survey of 132 cases of patients with spinal tuberculosis. Chin J Antituberc. 2015; 37: 276-9. doi:10.3969/j.issn.1000-6621.2015.03.011. (in Chinese)
6. Ma JJ, Lei GH, Li BY, He H, Dong WJ. Observation on efficacy of oral nutritional supplements among patients with spinal tuberculosis in perioperative period. Chin J Antituberc. 2016; 38: 257-61. doi:10.3969/j.issn.1000-6621.2016.04.005. (in Chinese)
7. Zhang ZC, Du P, Meng H, Guo H, Sun W, Wang SL, et al. Expert consensus on the implementation of enhanced recovery after surgery in posterior short-segment lumbar surgery. Chinese Journal Bone and Joint Surgery. 2019; 12: 401-9. doi:10.3969/j.issn.2095-9958.2019.06.01. (in Chinese)
8. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M; Educational and Clinical Practice Committee, European Society of Parenteral and Enteral Nutrition (ESPEN). ESPEN guidelines for nutrition screening 2002. Clin Nutr. 2003; 22: 415-21. doi: 10.1016/s0261-5614(03)00098-0.
9. Xu JY, Yang J, Kang WM, Lu Q, Jiang ZM. Expert consensus on clinical application of nutritional risk and nutritional risk screening tool Nutritional Risk Screening 2002 (2018 edition). Chinese Journal of Clinical Nutrition. 2018; 26: 131-5. doi:10.3760/cma.j.issn.1674-635X.2018.03.001. (in Chinese)
10. Weimann A, Braga M, Carli F, Higashiguchi T, Hübner M, Klek S, et al. ESPEN practical guideline: Clinical nutrition in surgery. Clin Nutr. 2021; 40: 4745-61. doi: 10.1016/j.clnu.2021.03.031.
11. Chakravarthy VB, Laufer I, Amin AG, Cohen MA, Reiner AS, Vuong C, et al. Patient outcomes following implementation of an enhanced recovery after surgery pathway for patients with metastatic spine tumors. Cancer. 2022; 128: 4109-18. doi: 10.1002/cncr.34484.
12. Xue JS. Correlation analysis of the intraoperative blood loss and postoperative drainage volume in lumbar interbody fusion and internal fixation. Shandong University, 2012. (in Chinese)
13. Bragg D, El-Sharkawy AM, Psaltis E, Maxwell-Armstrong CA, Lobo DN. Postoperative ileus: Recent developments in pathophysiology and management. Clin Nutr. 2015; 34: 367-76. doi: 10.1016/j.clnu.2015.01.016.
14. Mythen MG. Postoperative gastrointestinal tract dysfunction: an overview of causes and management strategies. Cleve Clin J Med. 2009; 76: S66-S71. doi: 10.3949/ccjm.76.s4.11.
15. Bianchi G, Ferretti P, Recchia M, Rocchetti M, Tavani A, Manara L. Morphine tissue levels and reduction of gastrointestinal transit in rats. Correlation supports primary action site in the gut. Gastroenterology. 1983; 85: 852-8.
16. Ljungqvist O, Scott M, Fearon KC. Enhanced Recovery After Surgery: A Review. JAMA Surg. 2017; 152: 292-8. doi: 10.1001/jamasurg.2016.4952.
17. Chakravarthy VB, Yokoi H, Coughlin DJ, Manlapaz MR, Krishnaney AA. Development and implementation of a comprehensive spine surgery enhanced recovery after surgery protocol: the Cleveland Clinic experience. Neurosurg Focus. 2019; 46: E11. doi: 10.3171/2019.1.FOCUS18696.
18. Miao RR, Xin SZ, Tang L, Ning HY, Bao YC, Zhang WL. Application of perioperative nutrition therapy in the treatment of spinal tuberculosis under the guidance of enhanced recovery after surgery. Chin J Antituberc. 2021; 43: 468-74. doi:10.3969/j.issn.1000-6621.2021.05.011. (in Chinese)
19. Yuan LZ. The effect of nutrition management under the concept of accelerated rehabilitation after surgery on patients with spinal tuberculosis during perioperative period. Clinical Medicine. 2023; 43: 74-6. doi:10.19528/j.issn.1003-3548.2023.07.023. (in Chinese)
20. Li LX. Effect of nutritional intervention on prognosis of elderly patients with thoracolumbar tuberculosis treated by operation. Chongqing Medical University, 2022. (in Chinese)