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Advance in Nutritional Status and Intervention after Spinal Cord Injury

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Abstract: Spinal cord injury (SCI) is a common disease in spinal surgery. SCI affects the metabolism of patients and changes their lifestyle. Nutritional problems may occur, which may be manifested as insufficient or overnutrition. Nutrition status is related to many complications and final outcome after SCI. In this paper, the nutritional status of patients with SCI and the progress of nutritional intervention were reviewed by comprehensive domestic and foreign literature. Medical staff should routinely screen and evaluate the nutrition of patients after SCI operation, and provide comprehensive nutritional intervention such as diet, exercise and dietary supplement.

Keywords: Spinal cord injury; Malnutrition; Overnutrition; Complication; Nutritional intervention

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1. Introduction

Spinal cord injury (SCI) refers to the damage of spinal cord structure and function caused by trauma and disease, which leads to the dysfunction of movement, sensation, urination and autonomic nerve below the injury plane. It is a serious disabling disease [1]. With the acceleration of modernization, traffic injuries, athletic injuries and work-related injuries are increasing. The incidence rate of SCI is increasing year by year. The incidence rate of SCI in the world is 12 to 65/10 [2]; the incidence rate of Japan is 39.4 to 40.2/10 [3]; and the incidence rate in China is 13 to 60/10 [4]. SCI affects the metabolism of patients, changes their lifestyle, and may have nutritional problems, which can be manifested as malnutrition or overnutrition [5]. Malnutrition or overnutrition after SCI are related to a variety of complications, such as infection, pressure ulcer, wound nonunion, decreased immunity, cardiovascular disease risk and osteoporosis. This paper aims to describe the research progress of nutritional status and nutritional intervention of patients after SCI, so as to provide basis for nutritional support for patients after SCI.

2. Research status of nutritional status of patients after SCI

2.1. Energy demand and metabolic characteristics of patients after SCI

In the acute stage of SCI, the metabolic rate of the body increases significantly after trauma, tissue catabolism intensifies, which accelerates the decomposition and utilization of protein and reduces protein synthesis, so it is prone to negative nitrogen balance and hypoproteinemia. Xiaobin Chen et al. [6] found that the nutritional status of patients with cervical SCI decreased after injury, and hypoproteinemia was the risk factor of death in such patients. The patient's spine is fixed and braked, and it is difficult to eat and water. In addition, paralysis after SCI is easy to cause psychological disorders. Emotions such as anxiety or depression will lead to decreased appetite and insufficient nutritional intake. If the complications such as pressure ulcer, pneumonia and urinary tract infection occur again, the metabolic rate in the body will be accelerated, which is more likely to cause nutritional disorder and malnutrition.

The UK multicenter study found that [7], 44.6% of SCI patients have malnutrition or are at risk of malnutrition. These patients had longer hospital stays and increased mortality within 1 year after injury. Domestic scholars have also found that [8], the incidence of malnutrition risk in SCI rehabilitation patients is 67.3%. After SCI, the motor function of patients was impaired, and the muscle cross-sectional area decreased in acute and subacute stages [9]. Studies have shown that [10], early exercise after SCI has a positive effect on muscle tissue.

During the recovery period of SCI, the patient's activity is limited due to paralysis, and the amount of activity is greatly reduced. If the food intake remains unchanged or increases, it is easy to produce excess nutrition and lead to obesity. Pellicane et al. [11] found that the total calorie intake of SCI patients increased significantly. Wong et al. [12] pointed out that overweight is a very common problem after SCI. Inactivity and decreased skeletal muscle are the promoters of insulin resistance, glucose intolerance and abnormal blood lipid metabolism, resulting in changes in body composition, relative increase of adipose tissue [13], and accumulation of fat in muscles and viscera [14-15]. Most studies believe that the basic metabolic rate is reduced in patients with SCI during recovery [16-17]. If they still follow the original diet without any modification, the daily energy intake of patients is easy to be greater than the body consumption, resulting in weight gain [18-20]. Tomey KM et al. [21] evaluated according to BMI and abdominal circumference and found that about 50% of SCI patients in convalescent stage were overweight, 19% obese and 7.5% underweight, and about 1/3 of them had excessive abdominal circumference. Groah SL et al. [22] found that 74% of SCI patients were overweight or obese according to BMI evaluation. A multicenter study found that [23], 45% of SCI patients were overweight and 15.3% were obese. In addition, due to long-term bed rest and lack of bone stress stimulation, the activity of osteoblasts is reduced and osteoclasts are significantly increased after SCI surgery, resulting in a large amount of bone loss. Furthermore, the incidence of vitamin D deficiency is increased due to lack of outdoor activities, insufficient nutritional intake and drug side effects, which will increase the risk of osteoporosis. Osteoporosis is a common complication in patients after SCI.

2.2. Relationship between nutritional status and clinical outcome after SCI

Nutritional status is related to many complications and final outcome after SCI. The study found that the infection and poor outcome in the acute phase of SCI are related to hypoalbuminemia [24-25]. Persistent hypoalbuminemia ($< 30g / L \geq 5$days) is an independent predictor of the adverse outcome in the acute phase of cervical SCI [26], and malnutrition is an influencing factor for the prolongation of mechanical ventilation time in patients with acute SCI [27]. Patients with low albumin in SCI are more prone to nosocomial infection [28-296]. Nutritional status is also closely related to long-term prognosis of SCI patients. Frisbie JH [30] followed up 322 SCI patients for 10 years. He found that the incidence of anemia, severe anemia and hypoalbuminemia in the death group was 2.4, 3.0 and 3.5 times higher than that in the survival group, respectively, and 95 patients with recurrent severe anemia and hypoalbuminemia had a 3-year mortality rate of 40%, while patients without severe anemia or hypoalbuminemia at 3-year follow-up had a survival rate of 99%. Obesity has long been considered to be the cause of cardiovascular inflammation, hyperlipidemia, insulin resistance, hypertension and thrombosis [13]. Nearly 41.9% of adults with chronic SCI suffer from obesity, which affects the rehabilitation training of patients [31] and slows down the rehabilitation progress. Studies have shown that 43% of patients with SCI meet the criteria of metabolic syndrome, and their systemic and local fat and visceral fat are higher than those of normal people [15]. Visceral adipose tissue is closely related to abnormal blood lipid and blood glucose after SCI [19,32]. In addition, excessive pro-inflammatory adipokines secreted by adipose tissue can lead to chronic and systemic inflammation. The health risks of cardiovascular and endocrine diseases related to physical adaptation are common in patients with chronic SCI [33-34], which is a common cause of abnormal death in patients with SCI [35].

3. Status of nutritional intervention in patients after SCI

3.1. Nutrition evaluation after SCI

The 2001 American Society for Parenteral Nutrition Guidelines recommend that the basic procedures of nutritional therapy include five steps: nutritional screening, malnutrition risk determination, nutritional status evaluation, nutritional intervention and nutritional treatment efficacy evaluation. Therefore, nutritional screening and evaluation of patients after SCI is the key first step of nutritional therapy.

The spinal nutrition screening tool (SNST) is a nutrition assessment scale specially developed for SCI patients by nutrition experts engaged in SCI treatment. It aims to overcome the limitations of other nutrition screening tools and avoid wrong results due to the changes of body composition after injury. SNST is evaluated by 8 items: age, body mass change, injury level, other diseases, skin condition, appetite, food intake and eating ability. The scoring results are divided into low risk, medium risk and high risk [36]. The detection rate of malnutrition risk in patients with early rehabilitation treatment is very high [37]. For the evaluation of malnutrition, in addition to nutrition screening tools, it should also be combined with objective indicators, including anthropometric indicators and laboratory indicators. Anthropometric indexes used more include body mass index (BMI), arm muscle circumference (AMC), triceps skinfold (TSF), waist hip ratio (WHR), etc. BMI can comprehensively reflect the nutritional status of patients, with simple measurement and more clinical applications, but it does not distinguish between muscle, fat and other components. Yarar Fisher et al. [38] suggested that paraplegic patients use BMI as an evaluation index of cardiovascular risk factors, but it is not applicable for patients with muscle atrophy, which will underestimate the proportion of fat. Skinfold thickness and muscle circumference are important and effective measurement indicators to evaluate body fat content and reflect human nutritional status. The skinfold thickness of triceps brachii and subscapularis is the best representative, and the subcutaneous tissue is balanced, and fat and muscle are easy to be separated, which is conducive to measurement. If the skinfold thickness of upper iliac-crest, abdomen and inner leg is measured, the representation of whole-body fat will be higher. It is of great significance for estimating the total body fat and evaluating the type of fat distribution [39].

Laboratory indicators commonly used are serum albumin (ALB), prealbumin, transferrin, lymphocyte count and hemoglobin, etc. ALB is an important index to judge malnutrition, but its half-life is long (16-21d), which cannot effectively monitor acute reactions. It is often used for nutritional control and monitoring. Prealbumin has a short half-life (2-3D) and high sensitivity, which is increasingly used to evaluate nutritional treatment response. Transferrin is a carrier protein of serum iron, which has an important impact on the metabolism of hemoglobin and iron, and can quickly reflect the changes of nutritional status and immune function. Hemoglobin and hematocrit can reflect the general condition of malnutrition. If the level is too low, it will reduce oxygen in the blood and affect wound healing. The total number of lymphocytes and delayed skin hypersensitivity can reflect the immune function of the body.

3.2. Nutrition intervention after SCI

The purpose of early nutritional support of SCI is to reduce the lack of nutritional substrate, protect the structure and function of tissues and organs, regulate immune and physiological functions, and prevent the occurrence of cell metabolism disorder and organ dysfunction; The purpose of nutritional support in the later stage of treatment is to accelerate tissue repair and promote the rehabilitation of patients. Frankenfield et al. [40] believe that daily protein intake of more than 2.0g/kg can improve the protein synthesis rate in the body and effectively maintain the nitrogen balance. Yuming Wang et al. [5] showed that exercise and diet intervention for overweight SCI patients can effectively reduce their weight. Studies have shown that the combination of diet and exercise is the most reasonable way to reduce obesity, diabetes, dyslipidemia and cardiovascular disease after SCI [41], while dietary supplements are a good supplement. The US dietary guidelines emphasize that the focus of dietary intervention for SCI patients should be to limit the intake of nutritious foods such as saturated trans-fat, cholesterol, and food added sugar, salt as well as alcohol. A low-fat diet (about 28% of total calories) has a mild and sustainable weight reduction effect compared with complex rather than simple carbohydrates [42]. Tsunoda et al. [43] found that simple diet to lose weight may lose muscle mass and bone, increase the risk of complications, and do not encourage rapid weight loss diet. Yarar Fisher et al. [38] believe that exercise training can promote the good changes of long-term paralytic and non-paralytic muscles in SCI patients, but only eating enough protein diet is not enough to achieve the goal of improving paralytic weakness. In addition, improperly adjusting the intake of calories or other major nutrients can eliminate the impact of any expected exercise on people [44]. Therefore, exercise combined with diet can make interventions more effective.

Micronutrients have become essential nutrients to maintain human health. The investigation on dietary intake and nutritional status of SCI patients found that [45], patients generally have insufficient micronutrient intake. Perret et al. [18] compared the nutritional intake of patients with acute and chronic SCI and found that the six vitamins (vitamin C, vitamin D, vitamin E, folic acid, pantothenic acid, biotin), potassium and iron in the two groups were significantly lower than the recommended amount. Beal et al. [46] found that the intake of vitamin D in SCI patients is much lower than the daily recommended amount. When the diet cannot meet the nutritional needs of the body, dietary supplements will become an auxiliary means. Studies have found that [47], dietary supplements are widely used in patients with chronic SCI, and more commonly used are compound vitamins (25%), calcium (20%) and vitamin D (16%). Studies have shown that [5,48], supplementation of nutrients such as calcium and vitamin D after SCI may play a role in bone health. The increase of dietary vitamin D intake may reduce the content of total cholesterol, maintain the stability of glucose in the body and improve the efficiency of insulin [46]. Bauman et al. [49] in the study of vitamin D supplementation therapy for SCI patients, found that giving 2000IU vitamin D to patients for 3 consecutive months can increase the level of 25-hydroxyvitamin D to the normal range. Vitamin E can improve sensory and autonomic dysfunction associated with SCI and has potential neuroprotective effects [50]. Patients with SCI pressure ulcer should regularly detect vitamin D and zinc [51-52], and timely supplement can promote wound healing [53] and maintain muscle strength [54].

Enteral feeding is the best way of nutritional supplement after SCI. If oral feeding is not available, nasogastric tube or even percutaneous endoscopic gastrostomy is recommended [55].

The nutritional status after SCI affects the functional recovery of patients. If malnutrition after SCI is not detected and treated, it may lead to serious problems, including prolonged hospital stay [7], increased hospital mortality [7], pressure ulcer [56], and the occurrence of nutrition related complications such as obesity and other cardiac metabolic complications [57]. In the past 50 years, the medical community has realized that early, active and effective nutritional support can reduce the complications of patients after SCI [58]. However, in clinical practice, clinicians and nurses rarely make a comprehensive and systematic evaluation of the nutritional status of patients after SCI, and generally have insufficient understanding of the malnutrition status of hospitalized patients after SCI [59]. As a rehabilitation doctor, while paying attention to the recovery of motor function of patients after SCI, we should also pay attention to the nutritional status of patients, and take nutritional screening and evaluation as an important part of SCI patient management. Nutritional guidance and support should comprehensively consider the patient’s energy demand and metabolic characteristics, and give individualized nutritional intervention in combination with the patient’s injury segment, injury degree, acute and chronic stage of disease, their own nutritional status and accompanying complications. The combined application of diet, exercise and dietary supplements will achieve twice the result with half the effort. In addition, the nutrition training of medical staff and the reform of hospital nutrition policy should also be paid attention to.

Disclosure statement

The authors declare no conflict of interest.

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