Malnutrition in Liver Cirrhosis:
The Influence of Protein and Sodium

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ABSTRACT

Protein calorie malnutrition (PCM) is associated with an increased risk of morbidity and mortality in patients with cirrhosis and occurs in 50%-90% of these patients. Although the pathogenesis of PCM is multifactorial, alterations in protein metabolism play an important role. This article is based on a selective literature review of protein and sodium recommendations. Daily protein and sodium requirements of patients with cirrhosis have been the subject of many research studies since inadequate amounts of both can contribute to the development of malnutrition. Previous recommendations that limited protein intake should no longer be practiced as protein requirements of patients with cirrhosis are higher than those of healthy individuals. Higher intakes of branched-chain amino acids as well as vegetable proteins have shown benefits in patients with cirrhosis, but more research is needed on both topics. Sodium restrictions are necessary to prevent ascites development, but very strict limitations, which may lead to PCM should be avoided.

KEYWORDS

Malnutrition; Liver Cirrhosis; Ascites

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INTRODUCTION

Although protein calorie malnutrition (PCM) leads to a poor prognosis for the liver patient, it is commonly undiagnosed due to the complications of liver disease such as edema and ascites, which make weight change detection more difficult in this patient population. However, PCM occurs in at least 50% and up to 90% of patients with liver cirrhosis and progresses as liver function deteriorates.[1,2]

Even if PCM is diagnosed in a patient, its importance is often underestimated by the physician and it is not considered a medical problem in need of immediate attention. However, it is important to note that malnutrition is an independent risk factor for predicting clinical outcomes in patients with liver disease[3] and is associated with an increased risk of morbidity, mortality,[1,2] biochemical dysfunction, compromised immune function, respiratory function, decreased muscle mass, increased recovery time, and delayed wound healing.[1] The development of other life-threatening complications of liver disease

such as refractory ascites, spontaneous bacterial peritonitis, hepatorenal syndrome, variceal hemorrhage, and post-transplant mortality are also significantly greater in patients with PCM.[1,4,5]

The pathogenesis of PCM is multifactorial and will be discussed in greater detail, however changes in protein metabolism and functions contribute largely to its development.[4] Previously, protein intake was restricted in the liver patient due to the effects of ammonia on the development of hepatic encephalopathy (HE). Currently, protein is considered to be a significantly important component of the diet in cirrhosis and is absolutely critical in order to avoid PCM and tissue wasting. Sodium restrictions, another typical component of the cirrhosis diet, have also been debated due to their effects on food palatability causing decreased intake and possibly contributing to PCM.

The purposes of this article are threefold: 1) to briefly review the roles of the liver in protein metabolism and the changes that occur during liver disease, as well as the pathogenesis of PCM; 2) to provide a selective review of the literature on protein requirements in liver cirrhosis, focusing on the different recommendations provided, as well as various protein sources; and 3) a selective review of the literature on sodium restrictions and current recommendations.

PROTEIN METABOLISM AND THE LIVER

The liver plays a crucial role in the metabolism of proteins along with carbohydrates and fats, the other two macronutrients. The liver carries out four main functions in protein metabolism.[4,6] The first is the formation of blood proteins, 80% of which are synthesized in the liver and secreted into the blood stream to perform many functions.[4] These blood proteins include clotting factors, carrier and transport proteins, hormones, apolipoproteins, and other proteins involved in homeostasis and the maintenance of oncotic pressure, such as albumin.

The liver is also involved in amino acid interconversion, its second main function. Amino acids are divided into two groups, essentials—those that our

body are unable to produce, which must be obtained from the diet and non-essentials, those that the body can synthesize. The liver is able to alter the structure of amino acids and transfer amino radicals to a keto acid to produce the amino acids needed for the body.[4] This process is critical in many body functions, especially gluconeogenesis.[4]

The third function of the liver in protein metabolism is amino acid deamination, or breakdown, the byproducts of which can be used to produce energy (ATP). Proteins however are not a desired source for energy, but will be used as that at times of starvation. The last of the four main functions is urea synthesis. Ammonia, one of the byproducts of protein breakdown is toxic to the body, and therefore the liver removes this excess ammonia by producing urea which is ultimately excreted by the kidneys.[4]

Besides these four functions, numerous other hormones in the body such as insulin, glucagon, epinephrine, and steroids also alter protein metabolism,[6] the effects of which can be amplified even more in the setting of liver disease. Because of the central roles that proteins play in the body, it is therefore easily predictable that changes in protein metabolism secondary to liver dysfunction can lead to many physiologic and chemical changes in the body, altering homeostasis. As explained by Charlton, it is believed that the loss of hepatic regulation of protein metabolism is what leads to a rapid death in acute liver failure,[4] and that changes in protein metabolism play a role in complications of chronic liver failure such as the development of HE, ascites and last but not least, PCM.[4,6]

PATHOGENESIS OF PROTEIN CALORIE MALNUTRITION

Generally, PCM occurs as a result of a deficit in calorie and protein intake.[4] The pathogenesis of PCM in liver disease is multifactorial and still not completely understood due to the multiple pathophysiologic processes and changes that simultaneously occur in this patient population, as a result of poor liver function. Several of these changes that are known to affect nutrition status of patients in-

clude: 1) decreased intake, 2) metabolic alterations, 3) increased β-adrenergic activity, and 4) malabsorption of fats.[1,2] Because the liver is unable to produce adequate amounts of bile, and because of decreased micelle formation, fatty acid malabsorption occurs which contributes to PCM by decreasing the amount of calories available for the body's use. Besides affecting the overall calorie levels, the other three changes mentioned above that lead to malnutrition have a direct effect on protein status.

Decreased intake

Patients with liver disease often experience anorexia secondary to the changes in the liver's control of the appetite.[4] According to Achord,[7] 90% of patients with advanced alcoholic liver disease experience anorexia. Many patients also experience other gastrointestinal (GI) symptoms such as early satiety, nausea, vomiting, diarrhea, constipation, indigestion, abdominal pain/distension, ascites, and reflux,[8] all of which lead to decreased oral intake. Hospitalized patients with any degree of HE also have poor nutrient intake since they are harder to feed due to the change in their mental status.

Hypozincemia, or zinc deficiency is associated with liver disease[1] and is caused by several factors, the first being decreased intake of foods high zinc as well as increased GI and urinary losses. Since zinc is bound to albumin and patients with liver disease typically have low albumin levels, patients may have adequate zinc intake. However, less zinc is able to be transported to body tissues where it is needed for different body functions. Zinc deficiency plays a role in the development of both anorexia, as well as dysgeusia or taste/smell changes, both of which can further contribute to a decreased food intake.[1,9] Patients with hypozincemia may report having either a dry mouth or a metallic taste. Zinc also has many functions in protein metabolism and a deficiency in this mineral can further alter protein status even with adequate protein intake.

Earlier dietary recommendations for cirrhotic patients have suggested a restricted protein diet. Although this is currently no longer recommended for long term use, if still practiced, it will lead to further decrease of protein intake. It is important to note that this factor's contribution to PCM is correctable and should be promptly addressed with adequate medicinal and nutritional interventions.

Metabolic changes

The metabolic alterations that occur are a result of hormonal and nutrient utilization changes are characteristic of liver disease. Because the liver is unable to synthesize and store adequate amounts of glycogen, glucose is not readily available from carbohydrate sources in the body. This causes an early occurrence of the "fasting state" which uses body sources of glycerol and amino acids, the compounds needed for gluconeogenesis or the production of glucose from non-carbohydrate sources.[10] An overnight fast in the cirrhotic patient is similar to that of a 72 hour fast in the healthy individual.[1] Therefore a constant breakdown of fat and muscle occurs. Unless these nutrients are resupplied to the body this can lead to tissue depletion and muscle wasting. About 80% of visceral protein sources are depleted in malnourished cirrhotic patients.[10] Studies looking at body composition changes in patients with cirrhosis have shown significant fat breakdown early on in liver disease that progresses to significant muscle depletion with severe liver dysfunction.[11] This is especially true for patients with decompensated cirrhosis.[3] One study has shown the possibility of a hepatic resistance to glucagon's stimulation of glycogenolysis, even in well-nourished patients with mild cirrhosis.[12] The authors, however, were unsure if this was the result of impaired hepatic sensitivity to glucagon or decreased hepatic glycogen stores. Insulin resistance, another hormonal change,[13] can also affect appetite and intake by altering ghrelin and leptin levels.[14]

Increased β-adrenergic activity

In one study, Greco et al. measured twenty-four hour energy expenditure (EE) and substrate oxidation of ten male patients. They observed that these patients exhibited hypermetabolism along with

other metabolic defects such as increased lipid utilization and insulin resistance, that together led to malnutrition.[15] This hypermetabolism is partly attributed to an increased β-adrenergic activity, by 25%,[16] which can affect muscle wasting and the protein status of the body. The hormones of the sympathetic nervous system (SNS) stimulate gluconeogenesis and over time can place the body in a hypermetabolic state, leading to increased muscle breakdown. Müller et al. have shown a significant elevation of plasma epinephrine (56%) and norepinephrine (41%) concentrations in hypermetabolic cirrhotic patients.[16] They explained that the metabolic rate per kilogram of body cell mass increased in malnourished cirrhotic patients and those with impaired hepatic circulation.[15,16] Hypermetabolism correlated with lean body mass rather than with the type, duration, and severity of liver disease.[3] Other studies have also found increased plasma catecholamines and the activation of SNS in cirrhosis.[17] According to Greco et al., hypermetabolism is present in some patients even when they have compensated cirrhosis. They believe proper nutritional interventions can prevent malnutrition[15] and possible decompensation of liver disease.

Considering all the different body changes that affect PCM, it is essential to properly identify, treat, and reverse malnutrition in the cirrhotic patient.

PROTEIN REQUIREMENTS

Although now changed, one of the variables in the original Child-Turcotte score was nutrition status,[10,13] which indicated its importance in the prognosis of patients with liver disease. As previously mentioned, poor nutrition status and malnutrition are associated with a greater risk of morbidity and mortality in patients with liver disease and should be taken seriously.

The first and most important step in identifying patients with possible PCM is performing a thorough nutrition assessment using the most appropriate tools to evaluate their food intake and body composition, followed by proper nutrition intervention.

Nutrition assessment—food intake

Methods of evaluating food intake in this patient population does not differ from other patients and are based on the preference of the professional who performs the evaluation as well as the literacy level of the patient. Some of these methods include 24-hour food recalls, food frequency questionnaires, calorie counts, and food diaries.[1] The 24-hour recall is perhaps the most rapid, low cost method, although it relies on the patient's memory and may be difficult to obtain in patients with encephalopathy or Alzheimer's disease.[1] A calorie count is probably the most accurate, however it relies heavily on detailed documentation of portion sizes as well as the knowledge to calculate calories based on food consumption.[1] This method may be best performed in a hospital setting by the nursing staff. A food diary and food frequency questionnaires both require the patient to have a high level of literacy. Although better at showing a trend in the patient's intake, both are time consuming for the patients to complete and for practitioners to analyze.[1] Depending on patient status, setting, and time limitations, practitioners should use the most appropriate of these methods to assess food intake.

Serum levels of albumin, one of the most abundant hepatic proteins, have long been used as a marker of nutrition status and malnutrition.[18] More recently, prealbumin levels that have a shorter half-life and are able to show changes more rapidly than albumin levels have been considered as the nutrition marker of choice by many practitioners. However albumin, prealbumin, and many of the other hepatic proteins such as transferrin are affected by numerous factors other than nutrition status.[18] They are negative acute-phase proteins, which means their levels decrease in response to infection/inflammation, injury, or trauma.[18] This is also true in liver disease and cirrhosis. The liver not able to produce as much albumin as previous and the disease process itself is a stressor on the body, causing a chronic state of inflammation which further causes a fluctuation in albumin levels.[2] This decrease in albumin and prealbumin levels occurs regardless

of the patient's nutrition status and the levels increase again only when the stressor on the body is removed. Therefore, they should not be considered markers of nutrition status in patients.[2,18] This understanding of hepatic proteins comes from studies on the pathogenesis of marasmus, a type of protein-energy malnutrition where serum hepatic protein levels are not affected by the inadequate intake of protein and are synthesized until very late in the process of malnutrition.[18]

These protein levels can instead be used to identify patients who are at a higher risk of becoming malnourished because the stressor on their body (inflammation, trauma, injury) can accelerate nutritional depletion.[18] Patients at risk for malnutrition should receive aggressive nutrition therapy. Another use for these hepatic proteins is to evaluate the effectiveness of nutrition therapy as one study by Casati et al. has reported that prealbumin and retinol-binding protein levels correlate positively with nitrogen balance of patients who receive parenteral nutrition.[19]

Nutrition assessment—body composition

Anthropometric measurements of height and weight, along with the body mass index (BMI) are the most quick and easy methods of determining the nutrition status of patients. However they are unreliable in patients with edema and ascites, whose dry weight is unknown.[1] Some patients may also have mild edema and ascites without knowing, again, making interpretation of the BMI inaccurate. A combination of anthropometric measurements, along with skinfold and waist/mid-arm circumference measurements is a more thorough method of evaluating body composition. These measurements are useful for detecting changes and identifying trends, however they are not good indicators of malnutrition in cirrhotic patients,[1] as studies have shown variable results that range from 11.6%-54%.[20]

Fernandes et al. compared several nutritional assessment methods in patients with cirrhosis and showed that the bioelectrical impedance analy-

sis (BIA) had a statistically significant correlation with each patient's Child-Pugh score.[20] Although possibly not readily available in all institutions, the BIA is considered to be an accurate tool in cirrhosis patients without ascites.[1] The BIA sends a small amount of current through the body. Percent fat, lean body mass, and body water are calculated based on the water content of different types of tissue and the speed at which the current passes through them. For example, adipose tissue has low water content, and therefore, the electrical current slows down passing through it, whereas it passes quickly through muscle because of its high water content. It is because of BIA's reliance on body water, that it will not accurately determine body composition in patients with ascites.

One method of malnutrition evaluation that takes the presence of edema/ascites into consideration is the subjective global assessment (SGA) which determines the degree of malnutrition based on changes in weight and dietary intake, the presence of GI symptoms (nausea/vomiting/diarrhea), patient's functional capacity, as well as a physical assessment of subcutaneous fat, muscle wasting, edema, and ascites.[21] The SGA is commonly used to detect malnutrition in liver patients since it is simple and cost effective.[2] However performing the SGA requires a trained professional, especially to perform the physical assessment accurately. Although compared to the BIA, SGA can be used in patients with ascites, studies show that it underestimates malnutrition in as many as 57% of patients[20] and does not seem to be a good predictor of patient outcomes.[1,21] The SGA is as the name implies, a subjective tool and the results obtained from the same patient may be interpreted differently by two healthcare professionals.[21]

Hand grip strength (HGS) can also be used to assess nutrition status; it has been found to identify 63% of malnourished cirrhotic patients, which is superior to the SGA.[22] In this method a dynamometer is used to measure the strength or energy exerted by the patient's non-dominant hand, the results of which are then compared to tables of normal values based on sex and age of healthy volunteers.[23]

One of the strengths of this method is that it better predicts complications of cirrhosis compared to the BMI, skin fold, BIA, and the SGA, however it does not correlate with the Child-Pugh score.[1]

Although they have limitations in some patients, the HGS and BIA may be used as the most reliable body composition assessments in most patients with cirrhosis.

Nutrition intervention—protein requirements of patients with cirrhosis

After a detailed evaluation of the patient's nutrition status, the most appropriate intervention should be performed for each patient. Previously, protein restrictions were considered a mainstay of treatment in liver disease[5,24] due to their contribution to ammonia production and the development of HE. However those recommendations were mostly the result of uncontrolled observational studies without strong scientific proof[24] and over the past few decades, new recommendations have been proposed by researchers studying the protein requirements of the cirrhotic patient that have changed practice guidelines.

Researchers have investigated different aspects of protein intake such as the amount and source of the protein consumed. Many studies have been conducted in an effort to reach a gold standard treatment; although they used different techniques and different outcome markers to evaluate their results, most researchers agree that the previous recommendations of protein restrictions should no longer be practiced. In fact, not only are the protein requirements of the cirrhotic patient higher than that of their healthy counterparts due to the changes in protein metabolism and PCM described earlier, there seems to be some evidence that patients with cirrhosis may also have protein-losing enteropathy, where portal hypertension causes excessive intestinal protein losses, further necessitating their need for a higher protein intake.[4]

However, many research studies have been conducted to show that there is no proven association between protein intake and HE, and that patients with protein restrictions often present with worse

HE and outcomes.[1,24] This is so because regardless of the lower protein intake, the patients' blood can still contain large amounts of ammonia. The only difference is that this ammonia is from the patient's body protein breakdown and amino acid release from skeletal muscles, as opposed to dietary protein metabolism.[24] In a randomized study, Cordoba et al.[24] divided patients with HE into two groups, one that received a normal protein diet (1.2 g/kg/day) and the other a low-protein diet that started at 0 g/kg/day and gradually increased to 1.2 g/kg/day. There was no significant difference in serum levels of ammonia, bilirubin, albumin, and prothrombin between the two groups at the end of the study.[24] Their results showed that a dietary protein intake of 0.5 g/kg/day was associated with increased muscle breakdown compared to 1.2 g/kg/day.[24] In another study restriction of protein to less than 1 g/kg/day increased the risk of protein wasting and negative nitrogen balance in patients with stable cirrhosis4 and possibly contributed to their progression to unstable or decompensated cirrhosis. Gheorghe et al.[5] also demonstrated that protein restriction was not required for the improvement of HE; 80% of their study participants showed significant improvements in their blood ammonia levels, mental status and Number Connection Test (NCT) results while on a high protein, high calorie diet (1.2 g protein/kg/day and 30 kcal/kg/day).[5] Nitrogen balance studies performed by Swart et al.[25] also determined that the minimum protein requirement of patients with cirrhosis, in order to be in positive nitrogen balance, was 1.2 g/kg/day. In their study, patients tolerated protein levels as high as 2.8 g/kg/day without developing HE.[25] Based on the results of these, and other similar studies, it is therefore believed that providing the patient with higher amounts of protein does not affect HE, but prevents muscle wasting and PCM in patients with cirrhosis.

Based on the most recent recommendations from the American Society of Parenteral and Enteral Nutrition (ASPEN) and the European Society Parenteral and Enteral Nutrition (ESPEN),[1,13] patients with cirrhosis should consume 25-40 kcal/kg/day based on their dry body weight and 1.0-1.5 g/kg

protein per day to prevent muscle catabolism. For patients with acute episodes of HE, a temporary protein restriction of 0.6-0.8 g/kg/day may be implemented until the cause of the HE is determined and eliminated, then a high protein intake should be resumed.[1] In general, patients with cirrhosis are advised to consume[4-6] small frequent meals throughout the day to be able to meet their higher needs. Researchers have recommended that the simple addition of a carbohydrate and protein-rich evening snack may also help nitrogen balance,[4,26] improve muscle cramps and prevent muscle breakdown by supplying the body with an overnight carbohydrate energy, and preventing gluconeogenesis.[27-29]

As with the amount, the source and quality of protein consumed by patients with cirrhosis have also been the subject of numerous research studies.

The branched chain amino acids (BCAA) leucine, isoleucine, and valine as well as the aromatic amino acids (AAA) tryptophan, phenylalanine, and tyrosine, are all essential amino acids. In liver disease, due to the altered amino acid metabolism that occurs, the body's amino acid profile and the ratio of BCAA:AAA changes to a higher AAA and lower BCAA,[1,6,27,28] possibly contributing to some of the complications that patients experience, especially HE. Supplementation with BCAA has been used to normalize this ratio. ASPEN does recommend the use of BCAA for hepatic encephalophathy,[1] but other uses of these supplements have also been suggested by researchers such as relief from muscle cramps,[6,27,28] improvement in immune function and inhibition of hepatocarcinogenesis.[7] Albumin synthesis is also regulated by leucine; therefore, patients who take BCAA supplements tend to have higher serum albumin levels,[7] overall better nutrition status and quality of life.[1,27]

Animal versus vegetable protein sources have also been compared in a variety of ways to determine the effects they may have on protein status, protein synthesis, ammonia levels and the development or worsening of HE.

Vegetable proteins are considered incomplete proteins because each lacks the required amount of one or more of the essential amino acids. They need to be eaten in combination with other vegetable proteins in order to provide the body with an adequate amount of all the essential amino acids. However, they are also typically lower in mercaptans, AAA and ammonia, all of which are considered to worsen HE, yet have an elevated BCAA content, which is assumed to be helpful in the prevention of HE.[30,31] One of the most common limiting amino acids in vegetable proteins is methionine, a sulfur-containing amino acid, that is broken down and metabolized in the intestines and liver, producing mercaptans or the sulfur analogue of alcohols (thiols).[32] These intestinal byproducts of methionine are known to be important in the pathogenesis of HE.[32] Since vegetable proteins are low in methionine, it is therefore thought that they may be better protein sources for patients with HE or those at a high risk of developing HE.[32]

According to Greenberger et al., in a case studies of three patients with HE treated with vegetable and animal protein diets revealed that vegetable protein diets resulted in lower HE index scores as well as decreased serum ammonia levels.[32] The patients who received animal proteins in this study had higher fetor hepaticus, which was also parallel to their mental status deterioration.[32]

In another study, Uribe et al.[30] also compared the effects of 40g and 80 g vegetable protein diets, along with a 40g animal protein diet. They found improved patient performance on NCTs while on both vegetable diets. However, patients on the 80g vegetable diet complained of the volume of food they need to consume for 80g of protein, since many vegetable protein sources are also rich sources of fiber and lead to increased fullness. Although a bit harder and bulkier to eat, the high fiber content of vegetable protein sources seems to have its own benefits on patients with cirrhosis, by decreasing ammonia levels.[9,30,33] Fiber causes an increase in fecal bulk and studies have shown that much of this increase in fecal weight is due to increased bacterial mass.[10] Colonic bacteria use nitrogen for growth and according to Amodio et al., a considerable amount of nitrogen is incorporated in the bacteria, in turn in feces, and then is excreted.[10,33] Fiber also causes in-

creased colonic motility and decreased transit time, further affecting nitrogen excretion.[10,33] Last but not least, fiber metabolism by intestinal bacteria creates a lower colonic pH, preventing ammonia absorption.[10]

Since foods that contain vegetable proteins are typically bulky and must be eaten in larger amounts to provide the body with adequate amounts of essential amino acids, a diet with vegetables as the sole source of energy may not be practical for patients, some of whom may also be experiencing decreased appetite or early satiety. Also, vegetarian diets have insufficient amounts of iron, and calcium.[10] Therefore, researchers have suggested that a diet which combines vegetable proteins and casein (dairy protein) may yield the desired result for this patient population.[5] A number of studies have shown less increase in blood ammonia levels after the ingestion of casein compared to the intake of other blood proteins.[10] In addition to consuming a decent amount of protein of high biological value (protein in a food that is readily absorbed), dairy products are also a rich source of BCAA. In a study by Gheorghe et al.,[5] the high calorie, high protein diet that patients consumed included a mixture of vegetable and milk-derived proteins, which as described lead to significant reduction in blood ammonia levels and improvements in NCT scores.

Although the results of these studies are promising, most have small sample sizes and further evaluation of the effects of vegetable protein sources on liver disease should be performed before specific diet recommendations can be given regarding their use instead of animal protein sources. Meanwhile, besides possible bloating with gas, and more frequent bowel movements which may occur in some patients,[34] vegetable proteins do not seem to have any adverse effects. Therefore patients may be recommended to increase their intake of these types of proteins, along with the consumption of other high biological value proteins such as eggs (or egg whites), lean animal meats such as fish, chicken, turkey, and of course low fat dairy, while avoiding excessive red meat consumption.[34]

SODIUM

Sodium is essential for the regulation of blood volume, blood pressure, osmotic equilibrium and blood pH. It is another nutritional element that may contribute to malnutrition in some patients. Sodium restriction is often the first diet intervention a liver patient receives, due to its effects on water retention and subsequently on the development of edema and ascites, or the accumulation of fluid in the abdominal cavity.

The mechanism by which excess sodium and fluid cause ascites formation is multifactorial, but is mainly a result of portal hypertension, a common characteristic of liver disease. Portal hypertension, caused by increased fibrosis of the liver, is partly compensated at first by vasodilation of the splanchnic blood vessels. However, as liver disease progresses, this compensatory mechanism fails causing a fall in arterial pressure and consequently the stimulation of baroreceptors that lead to an increase in the renin-angiotensin system, circulating catecholamines (vasopressin), and ultimately, sodium and water retention in the kidneys.[16,35] As renal sodium and fluid excretion decreases, fluid backs up in the interstitial tissue, causing edema and ascites as fluid leaks into the abdominal cavity.[35,36]

Ascites is considered one of the three major complications of cirrhosis[37] and is an important landmark in the progression of chronic liver disease. The development of ascites in turn may cause other complications such as abdominal pain, discomfort and difficulty breathing, as the fluid inside the abdomen presses against the diaphragm and the lungs, as well as the stomach, causing not only early satiety, but also reflux symptoms. The ascitic fluid may also become infected, causing bacterial peritonitis, which further causes pain, abdominal tenderness, and nausea.[36] The presence of ascites also increases the risk of other major complications such as renal failure, hepatic hydrothorax or variceal bleeding, among other complications that may occur as a result of paracentesis or removal of the fluid,[38] all of which justify the need for sodium restriction. Sodium restriction itself, however, will only eliminate ascites in approximately 10%-15% of patients.

Therefore other treatment options are also necessary.[36,39] Diuretics are used to increase urinary sodium excretion and fluid removal. As mentioned, paracentesis is also used for the removal of large volume ascites from the abdomen.[36,37]

Considering patients' desire, enjoyment, and of course their need to consume an adequate amount of food, the restrictions in sodium may negatively affect their nutrition status since low-sodium foods are unpalatable, leading to a decreased intake of protein and calories in general, which contributes to PCM.[39] Therefore the need for sodium restriction is sometimes challenged by researchers. Reynolds et al.[40] have observed no advantages to a sodium restricted diet and explained that a sodium restriction was not necessary for ascites treatment due to the potency of diuretics used, and that a normal sodium diet was advantageous for patients since it increased dietary palatability. Regardless of these advantages however, they acknowledged that although patients appreciated a diet liberal in sodium, they often objected to prolonged presence of ascites. In a randomized study, Gauthier et al.[41] also hypothesized that a normal sodium diet would increase appetite, and in turn improve nutrition status and 90 day survival of patients. They compared the effects of a sodium restricted diet to a normal sodium diet. However, their results showed that ascites disappeared significantly faster in the sodium restricted patients, and although survival was not overall significantly different in the two groups, for patients without a previous history of GI bleeding, survival was also significantly better in the sodium restricted group.

Although ascites are not a desirable symptom of liver disease, often representing the patient's change from compensated to decompensated liver cirrhosis, at the same time a strict sodium restriction also contributes to and may worsen PCM in cirrhotic patients.[37,39] It can also cause hypernatremia and diuretic-induced renal impairment.[42] Therefore, it is important to evaluate patients carefully and provide them with the treatment they would most benefit from, according to their signs, symptoms, and severity of liver disease. The American Association

for the Study of Liver Diseases' (AASLD) position paper on the management of ascites[37] reports that a dietary sodium restriction of ≤2000 mg/day is appropriate for the management of ascites. Fluid restriction is usually unnecessary, as water follows sodium passively.[37] Perhaps, patients who also have chronic hypertension may benefit from consuming approximately 1500 mg of sodium per day as advised by the American Heart Association.[43]

Patients receiving a sodium restricted diet should be given a thorough nutrition education on the reasons why sodium should be restricted. Although some cultures adapt to a sodium restriction more readily than others,[38] numerous patients are still noncompliant with this diet due to the unpalatability of food. Therefore, it is important for a dietitian to provide patients with alternatives to the use of salt to flavor food in order to enhance food intake and patient compliance. Patients need to know that the desire for salt is an acquired taste, and that it will change overtime.

CONCLUSION

PCM occurs in as many as 90% of patients with cirrhosis and leads to a negative prognosis for the patient by increasing the risk of other disease complications. The development of PCM is multifactorial and although protein and sodium are not the only contributing factors to PCM, they have strong influences and it is important for healthcare providers to first identify patients at risk of PCM. Second, healthcare providers should provide them with the best and most appropriate nutrition intervention beneficial to patient according to their needs, clinical status, and disease stage. Larger clinical trials investigating the use of vegetable-casein protein mixtures for patients with cirrhosis are needed.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this work.

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