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NUTRITION IN PEDIATRIC PATIENTS BEFORE LIVER TRANSPLANTATION

LECZENIE ŻYWIENIOWE U DZIECI PRZED TRANSPLANTACJĄ WĄTROBY

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Malnutrition leading to growth failure is one of the main problems in maintainig children with chronic liver diseases. Aggressive nutritional support (oral, enteral feeding with nocturnal intragastric tube, parenteral) with careful monitoring is essential, particularly where liver transplantation is considered.

Key words: chronic liver failure, malnutrition, nutritional support
Słowa kluczowe: przewlekła niewydolność wątroby, stan odżywienia, leczenie żywieniowe

INTRODUCTION

Malnutrition is one of the most severe problems in children with chronic liver diseases and may influence both short and long clinical outcome of these patients [13]. Nutritional management may depend upon the severity of cholestasis because in that condition a large amount of medium-chain triglycerides and fat-soluble vitamins is required for normal growth. But also in several anicteric cirrhotic diseases the nutritional problems may occure due to hypermetabolism, entheropathy and incresed protein oxidation. In children some liver disease may result from the certain inborn errors of metabolism such as tyrosinemia, galactosemia, hereditary fructose intolerance which require specific nutrition. Most pediatric candidates for orthotopic liver transplantation have prolonged cholestasis which very often starts in the neonatal period. In recent years the successful development of pediatric liver transplantation and novel surgical techniques that unable operations in small babies has put new emphasis on the importance of optimal nutritional managment [12].A poor nutritional status impairs the normal development and the quality of life in cholestatic children. It is also well recognised that malnutrition may contribute to impaired immune reactions in patients with chronic liver disease leading to an increased risk of serious and even life-threatening infections [1].

It has been clearly shown by many authors that a deteriorating nutritional status and malnutrition are major factors adversely affecting survival, both on the waiting list for orthotopic liver transplantation and following surgery [8, 5].

MECHANISM OF MALNUTRITION

In chronic liver diseases there is a number od potential causes of malnutrtion such as: reduced nutrient intake, increased energy expenditure, impaired fat and fat-soluble vitamin absorption and impaired carbohydrate metabolism [6]. Poor oral intake may be caused by recurrent infections, gastroesopageal reflux with oesophagitis, anorexia, nausea and vomiting. It may be aggravated by hepatosplenomegaly and ascites which makes food intake more difficult. Additionally some children do not tolerate the restriction of food intake, especially salt free diet.

Children with cirrhosis and portal hypertension have increased total energy expenditure. Some liver diseases such as Alagille syndrome, PFIC (progressive familial intrahepatic cholestasis), cystic fibrosis and choledocha cysts may be accompanied by pancreatic insufficiency, which aggravates the malabsorption [2].

CLINICAL COMPLICATIONS

The clinical complications of malnutrition in children with chronic liver diseases are very wide and include growth failure, rickets, bleeding and liver-threating infections. Patients specially at risk of malnutrition are thouse who are under 2 years of age, having severe cholestasis (bilirubin > 70 mmol/l, > 50% cnjugated), progressive liver disease (biliary atresia, neonatal cholestasis) and awaiting liver transplantation [4].

NUTRITIONAL ASSESSMENT

The first approach in the assessment of the nutritional status of children with chronic cholestasis is clinical examination. Anthropometric studies have clearly shown that weight and height values due to a combination of fluid retention and organomegaly may underestimate the degree of malnutrition. That is why more objective methods are required. Triceps skinfold measurements and upper-arm circumference measurements are much more accurate. In young children, particularly those with biliary atresia and Alagille's syndrome, a reduced head circumference is common [10].

Measurements of protein status, immunoglobulin level and nitrogen balance may indicate a poor liver synthetic function and should not be overinterpreted. The distribution of plasma fatty acids is important to detect essential fatty acid deficiencies. Also a vitamin level may be altered by several factors. Since vitamin E levels are strongly related to serum lipid concentrations, hyperlipidaemia present in many chronic liver diseases will additionaly lead to relatively decreased vitamin E levels. That is why it is necessary to express serum vitamin E in relation to total serum lipids. The levels of vitamins A, D and prothrombin time should be measured to prevent vitamin deficiency syndromes. Minerals and trace elements are also affected by malabsorption, poor excretion or impaired protein transport. In children with cholestasis, calcium, phosphorus, zinc and magnesium deficiency is common [7].

In all children with cholestasis a dietary history obtained by a dietician should include energy, protein, fat, carbohydrate and fluid intake as well as vitamin and mineral supplements intake. Three days faecal fat collection will help to estimate the colon absorption.

STRATEGIES FOR NUTRITIONAL MANAGEMENT (Fig. 1)

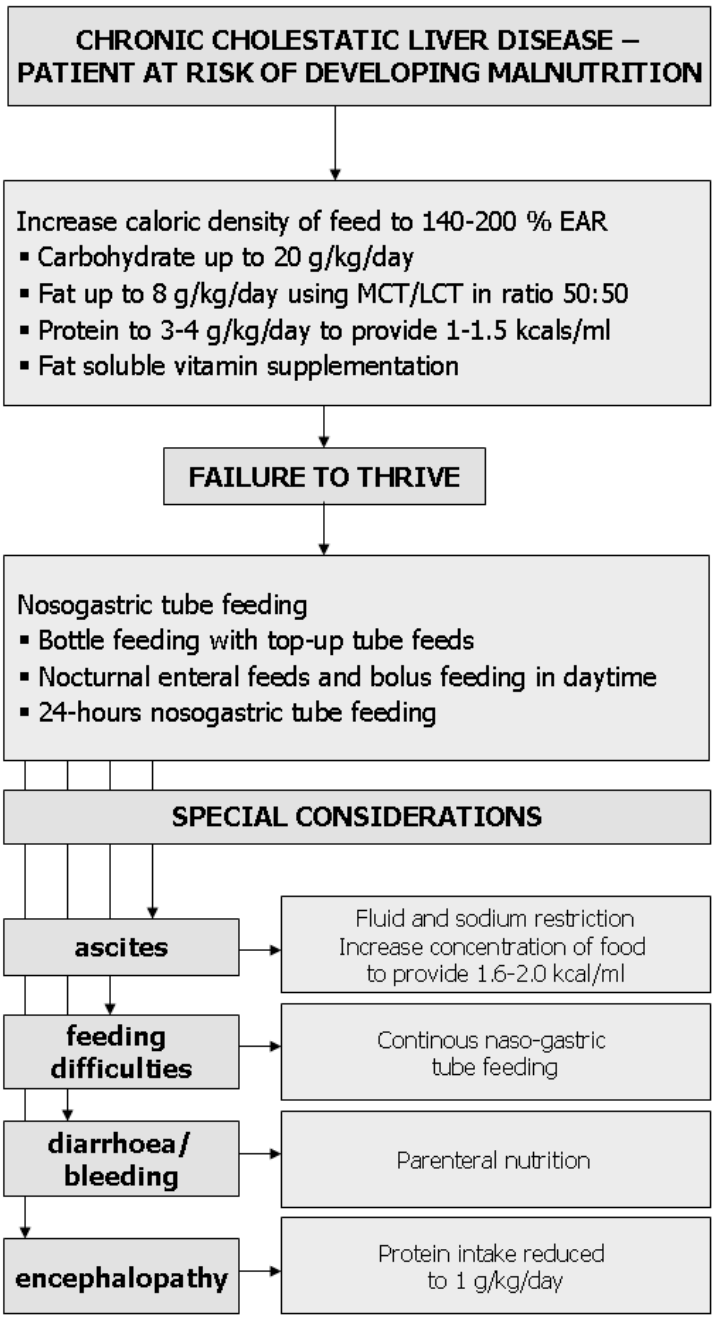

Fig. 1 Strategies for nutritional support of children before liver transplantation

Methods of increasing energy intake

Actual energy needs may vary depending upon age, degree of cholestasis, nutritional status and degree of malabsorption and can vary from 125 kcal/kg/day in children over 6 month of age to more than 150 kcal/kg/day in younger infants. This can be obtained by a high volume intake of infant formula, increased concentration of the formula (1 kcal/ml) or some nutrients (usually glucose polymers and some oil) added to the standard amounts of the formula. A formula that provides medium-chain triglycewrides (MCT) is used as the formula of choice.

Management of fat malabsorption

In cholestatic liver diseases medium chain triglycerides (MCT) are useful because intestinal absorption does not depend on incorporation into bile acid containing mixed micelles. MCT pass along the portal venous system and reach the liver more rapidly than the longer molecules. They can be quickly utilised as an energy source but are also ketogenic. Although MCT have been used in the nutrition of cholestatic children for a long time, it is still difficult to indicate which ratio of MCT to LCT should be preferable. Some studies pointed to the risk of essential fatty acid deficiency with a high content of MCT. The use of MCT has been shown to decrease steatorrhea and improve growth in children with chronic liver diseases [9].

The children should take up to 8 g/kg/day of fat with not more than 50% from MCT with additional essential fatty acid supplementation. The essential fatty acid dietary recommendation is up to 10 % of daily calories. Long-chain polyunsaturated fatty acids (LC-PUFA) such as arachidonic and docosahexaenoic acid play an important role in early human growth and development of membrane rich tissues such as the brain and retina [15].

Intravenous lipid emulsions (both MCT/LCT and LCT) are well tolerated in adult liver patients and in infants with cholestasis and they are a suitable source of energy as well as essential fatty acids.

Replacement of lipid soluble vitamins

In chronic cholestasis fat soluble vitamin supplementation, preferably in water-miscible forms, is mandatory. Careful monitoring is necessary to prevent subclinical deficiency and toxicity. Doses up to 15 000 IU/day (in USA even more) of vitamin A have been recommended. However, vitamin A toxicity can produce cerebral side effects and hepatotoxicity. Vitamin D supplementation can be managed by a special 25-hydroxylated vitamin D_3 oral administration and adequate sun exposure. Monitoring includes measurement of serum vitamin 25-0H D_3 and calcium as well as control of calciuria. Oral supplementation with vitamin K in recommended doses is individualised according to the prothrombin time. If the normalisation has not occurred the vitamin K needs to be given parentally at least twice a week. Correction of low vitamin E status with standard forms of vitamin E preparations is not successful due to an extremely poor intestinal absorption. Intramuscular administration seems to be an alternative but recently a water-soluble ester of vitamin E (α-tocopheryl polyethylene glycol 1000 succinate – TPGS) has been shown to treat efficiently vitamin E deficiency at a daily dose of 15-20 IU/kg body, weight [14]. In children refractory to such treatment, the use of an intravenous preparation is required.

Proteins

Adequate dietary protein must be provided so that endogenous protein is not oxidized. Up to 4 g/kg per day of protein is well tolerated in children without development of encephalopathy. The protein should be relatively rich in BCAA. In signs of encephalopathy protein restriction in a dose up to 1-1.5 g/kg may be required.

Carbohydrates

Carbohydrates should deliver 50% of daily calorie intake . Glucose polymers such as maltodextrin will produce a feed with adequate energy density.

It is generally recommended that children with chronic liver disease receive twice a double recommended daily allowance (RDA) of water soluble vitamins. Deficiencies of minerals should be treated individually.

Probiotics

Probiotics are defined as viable microorganisms that exhibit beneficial health effects when consumed in adequate amount. Most current probiotics are lactic acid bacteria, especially *Lactobacillus* and *Bifidobacterium* species. Treatment with probiotics influences the gut microflora resulting in the improvement of the intestinal barrier and functions of the immune system. Flora of the gut and probiotics have several very important functions in the body such as to reduce potentially pathogenic microorganisms, lower the amount of several various toxins and carcinogens. It also plays a role in releasing several nutrients, antioxidants and factors that modulate immune defence mechanisms from the plant fibres. Everyday consumption of probiotics is recommended for children with chronic liver diseases.

ENTERAL NUTRITION

The realimentation of patients should be well programmed and controlled by an experienced dietician.

The patient is advised to eat small but frequent meals, choose foods he likes, but always that of a high nutritional value.

The diet of the majority of cholestatic children is based on infant formula which is complete and easy to feed. Formula concentration should be slowly and meticulously increased above the standard to obtain maximal tolerance, it is helpful to achieve higher energy and protein intake.

In patients with fat restriction due to steatorhea, MCT supplementation is advised, with the emphasis on unsaturated fats. Special formulas with MCT oil are available (Pregestimil, Humana MCT, Bebilon-Pepti MCT, Alfare). Some special formulas with MCT additionally contain protein hydrolisate, which could be helpful in protein maldigestion and which improves nitrogen balance [11].

Excessive protein intake should be avoided because of toxic effects of end products of metabolism and elevated level of aromatic amino acids.

Glucose polymers could be added to all types of meals, because they are neutral in taste and do not increase osmolarity.

In children with ascites salt intake and fluid restrictions are necessary.

To achieve adequate energy and protein intake infant formulas could be supplemented with glucose polymers (Fantomalt), protein concentrate (Protifar) or MCT oil.

In general, whenever possible, the oral route of nutrition should be used but where there is already overt undernutrition enteral feeding with a nocturnal intragastric tube have been shown to be a safe and effective method. Nosogastric supplementation does not increase the risk of gastrointestinal bleeding and can provide a consistent hypercaloric intake in the face of anorexia and failing nutritional status.

PARENTERAL NUTRITION

The indications for parenteral nutrition in liver damage are: acute liver insufficiency with vomiting, nausea, hypo- or aperistalsis and severe malnutrition in patients with chronic liver insufficiency as preparation for liver transplantation [3]. Standard amino acid solutions are used as a source of protein. The only use of the modified amino acid solution (enriched with branched amino acids) is hepatic coma. Poor tolerance of LCT lipid emulsions (hypercholesterolemia, hypertriglicerydemia) is indication for the use of LCT/MCT lipid emulsion. Patients with liver insufficiency need more calcium, phosphorus, magnesium, zinc, vitamin A, E, D, K than children with a normal liver function. This requirement must be included in the individual programme of parenteral nutrition making use of intravenous additives.

CONCLUSION

Aggressive nutritional support shall be implemented in chronic cholestasis to obtain success of pediatric liver transplant programm. Chronic malnutrition in children with cholestasis can contribute to gradual hepatic deterioration and death from liver failure. The pretransplant nutritional status has a great impact on the postoperative morbidity and survival. Nutritional intervention should attempt to compensate for anorexia, increased energy requirement, malabsorption and abnormal hepatitic metabolism.

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NUTRITION IN PAEDIATRIC PATIENTS BEFORE LIVER TRANSPLANTATION

Summary

Malnutrition leading to growth failure is one of the main problems in maintainig children with chronic liver diseases. The pathogenesis of malnutrition is complex and includes reduced calorie intake, fat malabsorption, impaired protein metabolism and increased energy expenditure. The nutritional status is an important risk factor for survival post liver transplantation. Aggressive nutritional support with careful monitoring is essential, particularly where liver transplantation is considered. When the oral nutrition is inadequate, the enteral feeding with nocturnal intragastric tube should be started. In case of gastrointestinal intolerance, severe malnutrition and gastrointestinal bleeding, parenteral nutrition should be considered.

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LECZENIE ŻYWIENIOWE U DZIECI PRZED TRANSPLANTACJĄ WĄTROBY

Streszczenie

Zaburzenie stanu odżywienia jest jednym z głównych problemów w leczeniu dzieci z przewlekłymi chorobami wątroby. Wśród najważniejszych czynników etiologicznych niedożywienia w tej grupie chorych należy wymienić: zmniejszone spożycie pokarmów, upośledzone wchłanianie tłuszczów, nieprawidłowy metabolizm białek i zwiększone zapotrzebowanie energetyczne. Upośledzony stan odżywienia jest istotnym czynnikiem ryzyka zgonu po transplantacji wątroby, dlatego też intensywne leczenie żywieniowe odgrywa bardzo ważną rolę, szczególnie u pacjentów kwalifikowanych do przeszczepienia. U dzieci, u których żywienie doustne jest niewystarczające, należy rozpocząć żywienie nocne przez sondę. W przypadku nietolerancji żywienia enteralnego, niedożywienia znacznego stopnia lub krwawienia z żylaków przełyku pozostaje zastosowanie żywienia parenteralnego.

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