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Role of nutrition in cerebral palsy treatment – comprehensive literature review

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Abstract

Introduction and purpose:

A collection of symptoms known as cerebral palsy first manifest in early childhood and result in profound physical impairment. Cerebral palsy is thought to affect 1 in 500 live births, or roughly 17 million people worldwide. The type of cerebral palsy determines the clinical symptoms. Movement coordination disorders, epilepsy, muscle weakness, and feeding difficulties are the most common symptoms.

The purpose of this article is to familiarize readers with the options for nutritional therapy for cerebral palsy patients.

Material and methods

The following review was based on articles from the PubMed and Google Scholar databases. Key search terms included cerebral palsy; nutrition; treatment; gut microbiota..

State of knowledge

Early identification of malnutrition symptoms and appropriate interventions, such as the implantation of a percutaneous endoscopic gastrostomy tube in patients who are unable to swallow food, are the cornerstones of nutritional therapy for cerebral palsy patients. Dysphagia is a major problem in the population of patients with cerebral palsy, and multidisciplinary therapy is necessary for them. Patients' serum vitamin D levels are also influenced by their diet; 50% of those with cerebral palsy have a deficiency in this nutrient.

Conclusions

For people with cerebral palsy, nutrition is very important. Premature death may arise from malnutrition brought on by the disease's advancement. As a result, individuals with cerebral palsy need to receive specialized care that keeps an eye out for warning indicators and stops malnutrition from getting worse.

Key words: cerebral palsy; nutrition; treatment; gut microbiota.

Introduction

Cerebral palsy is a group of symptoms that appear in early childhood and cause severe physical disability. It is estimated that cerebral palsy occurs in 1 in 500 live births, affecting about 17 million people in the world. Therefore, it is the most common cause of physical disability in childhood [1,2,3]. Disorders that occur in cerebral palsy are permanent and non-progressive. The cause of cerebral palsy is still not fully discovered. Most likely, it is caused by incorrect development or damage of brain tissue that controls movement, posture, and balance. Structural problems in the brain may arise in the prenatal, perinatal, or early postnatal period, including hypoxia, hyperbilirubinemia, intracranial hemorrhage, or brain infection [3]. Diagnosis can be made before six months of corrected age and is based on the child's development over time. To diagnose, doctors use standardized tools such as magnetic resonance imaging, assessment of general movements, and neurological examination [1]. Cerebral palsy is divided into four types. The most common type of overall is spastic cerebral palsy, and the other types are ataxic, dyskinetic, and mixed [3]. Clinical symptoms depend on the type of cerebral palsy. The most frequent symptoms are movement coordination disorders, epilepsy, muscle stiffness, muscle weakness, tremors, and also problems with hearing, vision, and speaking. A common problem is symptoms from the digestive system cause feeding difficulties. Cerebral palsy forces high energy expenditure due to involuntary movements, combined with dysphagia, gastroesophageal reflux, constipation, and poor feeding, which can lead to malnutrition [3]. The treatment process lasts a lifetime and includes primarily physiotherapy but also pharmacotherapy or surgical procedures. The appropriate nutritional treatment of children with cerebral palsy is crucial in interdisciplinary treatment.

This article aims to introduce readers to the possibilities of nutritional treatment for children and adults with cerebral palsy.

Methodology

The following review was based on articles from the PubMed and Google Scholar databases. Key search terms included cerebral palsy; nutrition; treatment; gut microbiota.

State of knowledge

Methods for identifying malnutrition in patients with cerebral palsy

One of the main problems of cerebral palsy patients is malnutrition. According to the European Paediatric Society of Gastroenterology, Hepatology and Nutrition (ESPGHAN), reliance on height and weight measurements to determine a patient's nutritional status should be avoided. In addition, if height measurement is not possible, the increase in tibia length should be assessed. ESPGHAN recommends measuring the thickness of the skin fold when assessing the nutritional status of the patient. Performing dual-energy X-ray absorptiometry (DXA) scans to measure bone mineral density is important. Laboratory tests recommended for patients with cerebral palsy include urea and electrolytes, creatinine, glucose, blood morphology, hemoglobin, ferritin, ions, calcium, magnesium, phosphates, parathyroid hormone, albumin, liver enzymes, vitamins A, B12, D, E, folic acid, and zinc [4,5].

In addition, ESPGHAN has identified five warning signs related to malnutrition in children with neurological disorders:

1. Physical signs of malnutrition, such as pressure ulcers, skin problems, and poor peripheral circulation,
2. Weight for age with a score of <-2 ,
3. Triceps skinfold thickness <10 th percentile for age and sex,
4. Fat or muscle area in the middle of the arm <10 th percentile,
5. Weakening weight and/or lack of development [4].

In a cohort study by Huysentruyt et al. patients were classified according to the Gross Motor Function Classification System (GMFCS). Approximately 22% of children with GMFCS levels 1 and 2 had dysphagia, with a higher presence seen in children with higher GMFCS levels, reaching 53%, and 20% of this group had a gastrostomy. The highest degree of underweight, affecting up to 75% of patients, was seen in those with GMFCS level 5. Additionally, as GMFCS increased, so did the number of patients with a z-score of <-2 . Low

subcutaneous fat reserves in the arm, below the tenth percentile, were observed in 18.5% of patients with GMFCS level 4 and 30.1% with GMFCS level 5 [5].

According to a meta-analysis by Jahan et al. , an important intervention in the nutritional care of patients with cerebral palsy to detect malnutrition is the implementation of institutional care such as hospital care, regular access to a nutritionist and appropriate parental training [6]. A study by Brooks et al. clearly shows that malnutrition in cerebral palsy patients indicates a higher risk of death. Early implementation of nutrition intervention may prevent this, so it is important to look for appropriate screening methods to detect malnutrition [7].

Problems with dysphagia in patients with cerebral palsy

A clinical study conducted by Yi et al. showed that adults with cerebral palsy have a worse quality of life associated with swallowing than healthy individuals. This is associated with the following problems: choking with food about 75%, choking with liquids 60%, and problems with chewing food 60%. In addition, the meal time in adults with cerebral palsy is much longer than in healthy individuals [8].

In a cohort study conducted in a Swedish population of patients with cerebral palsy by Edvinsson et al. , swallowing problems occurred in patients with GMFCS levels 3, 4 and 5. In addition, younger patients with lower body weight had significantly greater problems with chewing and swallowing, drooling, and chewing and jaw muscle function compared to older patients. Similarly, a cohort study by Benfer et al. reported a similar relationship. In the group of children aged 18 to 34 months, dysphagia was present in 80%, while in children aged 60 months it was already 43.5%, which may be related to the ongoing rehabilitation of patients and the acquisition of motor control function with age [9,10,11].

Feeding people with cerebral palsy affected by dysphagia is complex. It is worth noting that with the age of the patient, co-morbidity increases and it may be necessary to consider the placement of a gastrostomy. In addition, people with higher GMFCS levels 4 and 5 have difficulty moving, thus weakening hand function and may not be able to eat on their own. It is important that patients with dysphagia have access to appropriately trained staff, such as speech pathologists trained in dysphagia or dietitians [8,10].

The Influence of Nutrition on Bone Health in Children with Cerebral Palsy

Proper nutrition affects bone mineralization in children. It's worth considering that factors beyond nutrition favoring this condition include factors such as immobilization, previous bone fractures, lower weight for age Z score, and age, with age, bone density decreases [12,13].

One of the factors is the level of vitamin D and calcium in the patient's blood. According to a cohort study conducted on a group of patients with cerebral palsy, 47.8% of them had vitamin D insufficiency and 30.4% had deficiency. Factors that may contribute to vitamin D deficiency include too short exposure to sunlight during the day, malnutrition, as well as difficulties in feeding and formula feeding. Additionally, the use of antiepileptic drugs such as carbamazepine, phenytoin, antiepileptic drugs using cytochrome P450-inducing, can lead to vitamin D absorption disorders, and patients belonging to this group should supplement vitamin D and monitor its level. Other drugs affecting absorption are proton pump inhibitors, which also affect the absorption of magnesium and calcium from food, elements that influence bone mineralization. Furthermore, vitamin D and calcium deficiency leads to changes in bone structure, which predisposes to bone fractures. These fractures most commonly occur in the lower extremities. In the treatment of calcium and vitamin D deficiencies in patients with cerebral palsy, vitamin D supplementation should be supplemented, and in the case of severe osteopenia, bisphosphonates should be considered. [12,13,14,15,16]

Another important factor influencing bone health in patients with cerebral palsy is providing the body with an adequate amount of calories, protein, micronutrients (like zinc, magnesium, phosphorus), and vitamins to prevent malnutrition, and thus a decrease in muscle and bone mass in patients [12,13,17,18,19].

Operative interventions in nutrition in patients with cerebral palsy

Operative intervention to provide enteral access for feeding individuals with cerebral palsy is a last resort. Percutaneous endoscopic gastrostomy is preferred over gastrojejunostomy and jejunostomy, as the latter can lead to gastroesophageal reflux and vomiting. It is performed when the total mealtime during the day exceeds 4 hours, oral intake does not satisfy approximately 80% of the daily caloric requirement, there is no weight gain observed, and the triceps skinfold is consistently <5th percentile for age. The decision for surgery and

placement of percutaneous endoscopic gastrostomy should be made by a specialized team. Factors to consider include the method of feeding, whether bolus or continuous, depending on the patient's tolerance and the caregiver's capabilities. Side effects of feeding through percutaneous endoscopic gastrostomy include the risk of self-inflicted damage to the feeding tube and infections at the surgical site [20,21,22,23,24].

Studies show that early placement of gastrostomy allows for proper weight gain and growth in patients. In a retrospective cohort study conducted by Civan et al. on malnourished patients with cerebral palsy, all patients showed growth in height, weight, and triceps skinfold thickness six months after percutaneous endoscopic gastrostomy placement. Additionally, the number of patients with low hemoglobin decreased. [23,25]

The impact of drugs used in cerebral palsy on the patient's nutritional status

Among the typical drugs used in cerebral palsy are anti-convulsants, intrathecal baclofen, bisphosphonates, and diazepam. The use of these drugs is associated with clinical benefits for the patient such as reduction of muscle tension, decrease in the frequency of seizures, as well as increase in bone density [26].

When using bisphosphonates, side effects such as diarrhea, abdominal pain, and heartburn may occur. Additionally, they may cause gastritis, duodenitis, and inflammation of the oral mucosa. This necessitates additional medication for the patient and sometimes renders them unable to eat. Furthermore, gastric mucosal inflammation leads to poor absorption of iron and may result in anemia [27,28,29].

The main side effects of antiepileptic drugs include asthenia, insomnia, somnolence, depression, ataxia, tics, and concentration problems. Side effects of antiepileptic drugs leading to nutritional disorders include nausea, vomiting, abdominal pain, diarrhea, and anorexia. Additionally, antiepileptic drugs affect the metabolism of vitamin D, causing a decrease in its serum concentration. It is important to remember that when using carbamazepine, one should avoid consuming grapefruit, as grapefruits inhibit CYP 450 and increase carbamazepine bioavailability [30,31,32].

Neurodevelopmental therapy of feeding and swallowing of patients with cerebral palsy

Neurodevelopmental therapy is indeed a crucial approach in the treatment of patients with cerebral palsy. Its goal is to help individuals maintain functionality, alleviate spasticity, prevent osteopenia, acquire new movement patterns, and reduce muscle pain. It's recommended that individuals engage in daily physical activity tailored to their physical abilities [33,34].

When it comes to feeding, improving swallowing function is essential. A clinical control study conducted by Abd-Elmonem et al. aimed to confirm the effectiveness of sensorimotor stimulation on oropharyngeal dysphagia in children with spastic quadriplegia. The study demonstrated that this method significantly improves oral motor function compared to the control group. Another study utilizing the Neurodevelopmental Therapy Method-Bobath showed improvement in oral motor assessment [35,36].

It's important for children with cerebral palsy to participate in meals with their families as part of therapy. Even if they are fed through percutaneous endoscopic gastrostomy, they should be fed orally with small amounts of food. Continuous care by a multidisciplinary team is crucial for the patient's well-being [37].

Gut Microbiota in Cerebral Palsy

In recent years, there has been an increasing number of studies aimed at determining whether gut microbiota influences the onset and progression of diseases. Such studies have been conducted in patients with Attention deficit Hyperactivity disorder, Alzheimer's, Parkinson's, and depression [38].

Research on gut microbiota in cerebral palsy has also been conducted to detect disorders contributing to the development of the disease. According to Wang et al., gut microbiota influences the development of brain damage in premature newborns. The gut microbiota participates in the process of neuron formation, microglial maturation, myelination, and the formation of the blood-brain barrier. It is important for a child to be colonized at an early stage by maternal bacteria such as *Bifidobacterium*, *Clostridium*, *Lactobacillus*, and *Bacteroides*. Prematurely born children often do not experience this because from the first moments of life, they are directed to the neonatal intensive care unit where their lives are often fought for [39].

According to a meta-analysis conducted by Upadhyay et al., comparing the use of probiotics and prebiotics in preterm infants with very low birth weight, there is no consensus on whether the use of these drugs during the neonatal intensive care unit stay increases or decreases the likelihood of cerebral palsy in the child later on [40].

According to a cohort study conducted by Huang et al., the type of diet, which is often liquid, used by individuals with cerebral palsy affects the gut microbiota. In the group of subjects fed with liquid food, *Fusobacterium*, *Bifidobacterium*, *Alloprevotella*, and *Lachnospiracea incertae* are observed. Intervention involving the introduction of larger amounts of fiber and probiotics into the diet significantly affects patients, facilitating bowel movements and increasing the amount of bacteria such as *Lactobacillus* and *Bifidobacterium* in the gut microbiota [41].

In children with epilepsy and cerebral palsy, higher amounts of bacteria such as *Enterococcus*, *Bifidobacterium*, *Akkermansia* and *Clostridium*, are observed. *Clostridium* may be associated with the development of gut dysbiosis. *Bifidobacterium* indicates immaturity of the gut microbiota. An increase in the amount of *Akkermansia* bacteria leads to inflammatory processes in the body. Moreover, an increase in the amount of *Akkermansia* bacteria in the gut microbiota is observed in patients with Parkinson's disease [43,44].

Gut microbiota represents a new direction of research, and it is important to understand the precise pathomechanisms behind the influence of gut microbiota on cerebral palsy.

Conclusions

Nutrition is an important factor in the treatment of patients with cerebral palsy. Proper nutrition introduced at an early age helps prevent malnutrition and premature death in patients. Rehabilitation throughout the patient's life is important because it helps prevent complications of the disease that impact the patient's quality of life and improve the patient's functional abilities. Patients with cerebral palsy should be under constant clinical care to detect signs of malnutrition as early as possible.

Author's contribution

Conceptualization, Iwona Welian-Polus, Karolina Gendek; methodology, Mikołaj Smach; software, Karolina Gendek; check, Iwona Welian-Polus, Magdalena Mazur, Joanna

Ziółkowska; formal analysis, Izabela Oleksak, Michał Leśniewski, Mikołaj Smach; investigation, Iwona Welian-Polus, Joanna Ziółkowska, Magdalena Mazur; resources, Karolina Maliszewska, Wiktoria Wilanowska, Karolina Gendek; data curation, Bartosz Mazur, Wiktoria Wilanowska, writing – rough preparation, Mikołaj Smach; writing – review and editing, Iwona Welian-Polus, Magdalena Mazur; visualization, Michał Leśniewski, Bartosz Mazur, supervision, Izabela Oleksak; project administration, Karolina Maliszewska; receiving funding, Bartosz Mazur.

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