

## Short Communication

### Protein Calorie Malnutrition

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#### Abstract

Protein Calorie Malnutrition (PCM) or Protein Energy Malnutrition (PEM) is one of the most widespread nutritional deficiency diseases in our country and poses a health problem in children below five years of age. This paper explains the clinical features of this malnutrition including kwashiorkor, marasmus and marasmic kwashiorkor. It also describes the biochemical changes including protein, carbohydrate, fat, water and electrolyte metabolisms, hormonal changes, hematological changes, pathological changes and changes in mental development occurring during protein calorie malnutrition. It also gives an idea about the measures which could be adopted for preventing this nutritional syndrome.

#### Introduction

Protein Calorie Malnutrition (PCM) or Protein Energy Malnutrition (PEM) refers to various degrees of nutritional disorders caused by inadequate quantities of protein and energy in the diet. This is one of the most widespread nutritional deficiency diseases in India and covers a broad spectrum ranging from marginal deficiency with loss of weight and poor growth to a severe deficiency in which the body develops oedema, respiratory infection and diarrhea. Besides high child mortality due to severe protein calorie malnutrition, permanent sequel including stunted growth, poor learning ability and reduced work efficiency may occur in those who survive. The classical syndromes of protein energy malnutrition include kwashiorkor, marasmus and marasmic kwashiorkor. Oedema is the striking feature of kwashiorkor while severe growth retardation and wasting are the cardinal feature of marasmus. Combined forms showing both oedema and wasting which are common are known as marasmic kwashiorkor. The disease is prevalent in children below five years of age when they are weaned from mother's milk and the diet substituted is lacking in sufficient protein and energy or protein only.

#### Clinical Features of Protein Calorie Malnutrition

##### Kwashiorkor

The term kwashiorkor was first introduced by Dr. Cicely

Williams in 1934 while working in West Africa. Kwashiorkor means "The sickness a child develops when another baby is born" in the language spoken in Ghana. The three essential features of kwashiorkor include growth failure, oedema (swelling of legs and feet) and mental changes [1].

**Diagnostic signs:** Growth failure can be assessed by the body weight which is low in spite of oedema. Some degree of muscle wasting also occurs but it may be masked by the oedema. Pitting oedema appears first on the feet and legs and later on spreads to the whole body. The face looks puffy with sagging cheeks and swollen lips. Abdomen is distended and liver is enlarged because of fatty infiltration. Mental changes like apathy and irritability are common features.

**Other variable features:** Apart from the diagnostic signs, there are other variable features like scaly pigmentations of the skin and in severe cases the epithelium peels off leaving being pigmented patches with oozing fluid called "Crazy pavement dermatosis". The hair shows changes in texture as well as color. It becomes thin, dry and can be pulled out easily without causing pain, loss of hairs results in diffuse or patchy alopecia. The changes in hair color include brownish or reddish discoloration. As a result of secondary infection, anorexia and diarrhea occur. Vitamin A deficiency takes place which leads to exophthalmia. Deficiency of B-complex vitamins takes place which results into Glossitis and angular stomatitis. Deficiency of iron and folate in kwashiorkor leads to anemia.

## Marasmus

Marasmus can occur at any age but most severe cases are observed in children below two years of age. Infantile marasmus can occur even under one year of age when there is early weaning due to lactation failure or death of the mother. The marasmus may occur due to many reasons which include inadequate supply of mother's milk to meet the nutrition need of infants, non-supplementation of breast feeding with other food at the age of five to six months and substitution of inadequate and unsanitary formulations for breast feeding [2].

**Diagnostic signs:** The diagnostic signs of marasmus include severe growth retardation, loss of subcutaneous fat, severe muscle wasting, associated vitamin deficiencies and absence of prominent signs of kwashiorkor like oedema and fatty infiltration of liver. Child looks very thin with shriveled body, wrinkled skin and bony prominences.

## Marasmic Kwashiorkor

In marasmic kwashiorkor, the symptoms of both marasmus such as muscle wasting and of kwashiorkor such as oedema are seen. The malnourished children suffering from kwashiorkor have varying degrees of muscle wasting, oedema as well as hair and skin changes in this type of malnutrition. Transition from one form to other may take place. A marasmic child can develop oedema after infection occurs. On the other hand, on the treatment of marasmic kwashiorkor, oedema disappears but child becomes marasmic. The diagnostic signs of both kwashiorkor as well marasmus will be applicable on this type of malnutrition.

## Biochemical Changes in Protein Calorie Malnutrition

In severe protein calorie malnutrition, a number of biochemical and metabolic abnormalities appear varying with the severity and type of malnutrition. Metabolism of major nutrients and electrolytes are adversely affected which are described below [3].

### Protein Metabolism

In PCM, serum concentration of total proteins decreases due to reduced albumin synthesis. The levels are lower in kwashiorkor than in marasmus. Serum concentration of other proteins like pre-albumin, transferrin, ceruloplasmin and retinol binding protein are also reduced. Total serum amino acid concentration is reduced due to decrease of essential amino acids particularly the branched chain amino acids. Enzymes like amylase, lipase and cholinesterase are reduced in kwashiorkor but they are not altered in marasmus. Moreover, urea excretion is reduced in malnourished children reflecting a reduction in muscle mass.

### Carbohydrate Metabolism

In malnourished children, the fasting blood sugar levels are generally lower. Severe hypoglycaemia in children suffering from kwashiorkor may sometimes occur.

## Fat Metabolism

The activity of pancreatic enzyme lipase is reduced in children having kwashiorkor. Moreover, plasma levels of free fatty acids increase while there is reduction in triglycerides, phospholipids and cholesterol. There is reduction in the synthesis of lipoproteins creating a defective transport mechanism which results in fatty infiltration of the liver. In marasmus, on the other hand, plasma levels of lipoproteins, triglycerides and free fatty acids are normal or raised.

## Water and Electrolyte Metabolism

The occurrence of oedema and kwashiorkor results in the retention of fluids in the body, mostly in the extracellular compartment. The primary cause of oedema is due to inability of the kidney to excrete sodium load. Some of the abnormalities which occur in PCM include glomerular filtration rate, lower renal plasma flow and reduced osmolar filtration. Higher erythrocyte levels of sodium are observed in malnourished children. There is a reduction in potassium concentration of serum and erythrocytes in kwashiorkor. There is an increase in intracellular sodium concentration and the total body potassium is lowest in children having oedema and is inversely related to extracellular fluid volume.

## Hormonal Changes

Alteration in hormone levels due to PCM can also lead to fluid retention. Plasma levels of aldosterone are raised in kwashiorkor but they are not altered in marasmus. This in turn leads to sodium retention at the level of kidney tubules, rise in Anti Diuretic Hormone (ADH) secretion, water retardation and oedema leading to kwashiorkor. The plasma cortisol levels are raised to a greater extent in marasmus than in kwashiorkor. Raised cortisol levels lead to breakdown of muscle protein and the released amino acids are diverted to liver for synthesis of plasma proteins. Somatomedin activity is reduced in kwashiorkor but not in case of marasmus. Low levels of both plasma amino acids somatomedins may be operating as a feedback stimulating pituitary gland to secrete increased quantities of growth hormone. Plasma growth hormone levels are raised in kwashiorkor and their lypolytic action gives rise to high levels of plasma free fatty acids. Fats accumulate in the liver due to reduced synthesis of lipoprotein and impaired hepatic function gives rise to biochemical changes and oedema characteristics of kwashiorkor.

## Haematological Changes

In PCM, the haematological changes include moderate anaemia, reduction in hemoglobin synthesis and total red cell mass, shortening of life span of red cells and occurrence of abnormalities of the red cell membrane, cell metabolism and composition and decrease in neutrophil leucocytes due to infection. The associated iron deficiency may lead to microcytic anaemia with known stainable iron in the bone marrow. Serum vitamin B<sub>12</sub> levels increase.

In severe kwashiorkor, purpura and bleeding manifestations are seen in 10 to 20% patients. The platelet count decreases and the bleeding time prolongs in patients with purpura. In malnourished children with bleeding manifestation, effects of prothrombin complex and clotting factors have been observed.

## Pathological Changes in Protein Calorie Malnutrition

### Gastrointestinal Tract

In PCM, atrophy of the mucosa commonly occurs particularly in the jejunum. The villi are flattened and crypts are elongated. There is a marked infiltration specially lymphocytes and plasma cells. The mucosal changes decrease the enzyme activities which in turn lead to poor digestion and absorption. In kwashiorkor, the liver becomes grossly infiltrated with fat and hepatomegaly is a common feature. The fat appears as small droplets, which coalesce to form large globules, distending the cell. This change is initially noted at the periphery of hepatic globules and then spreads towards central vein until the whole liver is affected. In severe PCM, pancreas is also markedly affected. Acinar cells shrink and the nuclei become pyknotic. A varying degree of duct proliferation also occurs. Muscle wasting is a characteristic feature in severe protein calorie malnutrition. Apart from the reduction in the muscle mass, structural changes like reduction in individual fiber, increase in interstitial connective tissue also takes place. Muscle fiber shows degenerating changes. Muscle wasting is also in other organs like intestine and heart. The myocardial fibers show variation size in with vacuolation and patchy necrosis. Moreover, atrophic changes in all endocrine glands take place. The thymus is very much reduced in size in children having severe PCM, as result there is depletion of lymphocytes and loss of germinal thymus-dependent lymphocytes is related with impaired cell-mediated immunity [4].

### Mental Development

One of the most severe consequences of protein calorie malnutrition is the arrest of mental development of children. In malnourished infants, there is a reduction in head circumferences and brain size, a decrease in the number of cells in the cerebellum and brain stem. Malnutrition in early childhood has been found to have permanent retarding effect on intellectual development.

### Prevention of Malnutrition

Protein calorie malnutrition can be prevented by solving some of the socio-economic problems like eradication of poverty, enhancing the purchasing power of the population and providing nutrition education. It is a consequence of not only inadequate food intake but also of poor living conditions, unhygienic environment and lack of health care. However, following measures could be adopted to combat this nutritional syndrome.

### Supplementary Feeding

In rural community, especially the children are nourished by mother over long period and supplementary foods essential to prevent PCM are not provided at the proper age. Sometimes even when supplementary foods are fed to the infants; they are insufficient and may not contain enough protein and calories. In India, Supplementary feeding programmed has been in operation for the past several years. Preschool children are given daily food supplement which contribute significantly to the protein and energy intake. Presently, efforts are being made to increase calorie density of supplementary food so as to provide sufficient energy besides protein. The National Institute of Nutrition, Hyderabad and many Home Science Colleges in India have developed several nutrition recipes which are based on locally available food like cereals and pulses. In order to increase the calories in these supplementary recipes, small amounts of fat are also needed. Malting of grains and preparation of amylase rich foods from wheat or maize is helpful in reducing the bulk of the cereal mixture. Preparation of such weaning foods at home level utilizing the locally available resources would certainly help in preventing the PCM to a considerable extent.

### Integrated Child Development Services

The success of the supplementary feeding programmed will depend on the environment and infection control. Supplementary nutrition should, therefore, be integrated with other health activity like immunization, treatment of minor illness and growth monitoring and health education under the Integrated Child Development Services (ICDS). The programmed could not gain success to the desired extent due to inadequate coverage of children under 3 years of age and neglecting the environment and education. Efforts are, therefore, needed to enhance the coverage of younger children and improve the environment and control infection. It is also important to impart proper training to ICDS workers so that precise advices could be given to mothers for improving diet of the children with the existing resources.

### Nutrition Education

Nutrition education is one of the most important measures to prevent protein energy malnutrition. Breast feeding and timely introduction of supplements are important factors which need be included in nutrition education programmed. Emphasis should be given on exclusive breast-feeding during first four to six months. Bottle feeding is generally practiced in many communities. However, many mothers do not have any knowledge of the precaution one should take using this method of feeding infants. Bottles and nipples are not washed properly after every feed and sometimes the milk stays in the bottle for long period allowing growth of pathogenic organism. These unhygienic conditions lead to diarrhea and other disorders. The major factors responsible for mal-

nutrition are delayed supplementation and inadequate weaning foods. Mothers should be advised to give supplements based on cereals, pulses and oils. In addition, mashed vegetables and fruits should also be included in the diet of children. The health worker should advise on the quality and quantity of food required by the child and should check growth chart of the child so as to assess the adequacy of nutrition.

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