Physiology

Malnutrition (Kwashiorkor and Marasmus) — Symptoms and Treatment

See online here

One of the most common reasons for the death of almost 300,000 children per year is malnutrition. It is seen more frequently among children who are younger than five years and reside in the developing countries. The number contributes to half of the total deaths in the child age groups across the world. Protein-energy malnutrition (PEM) is a type of malnutrition commonly seen among children aged six months to 5 years.

Types of Malnutrition

- **Kwashiorkor**: insufficient protein consumption
- **Marasmus**: energy deficiency
- **Marasmic kwashiorkor**: deficiency of both calories and protein

**Kwashiorkor**

Kwashiorkor is a debilitating and life-threatening condition caused by the lack of protein in the diet.
Distribution of kwashiorkor

It is commonly seen in the following areas:

- Famine-stricken
- Limited food supply countries
- Greater illiteracy rate countries

Pathophysiology of kwashiorkor

Lack of protein results in an osmotic imbalance and irregularities in the lymphatic system. Three major functions served by the lymphatic system of the body are:

- Fluid recovery
- Immunity
- Lipid absorption

In the case of protein sub-nutrition, the victim exhibits reduced ability towards fluid recovery; there is a lack of immunity, and lipid absorption does not take place sufficiently.

Lack of proteins results in zero substantial pressure gradient and, therefore, a failure to draw fluids from tissues into the bloodstream. This leads to the pooling of fluids in the abdomen.

Failure of fluid recovery by the lymphatics results in edema and belly distension, which is the typical presentation of an undernourished child. Edema caused as a result may trick the parents into thinking that the child is well nutritioned despite the lack of protein intake.

Signs and symptoms of kwashiorkor

For an undernourished child suffering from Kwashiorkor, pitting edema is the characteristic sign. Other signs and symptoms include:

Image: “Protruded belly in a child suffering from kwashiorkor.” by Dr. Lyle Conrad – Centers for Disease Control and Prevention, Atlanta, Georgia, USA Public
Weight loss: there is decreased muscle mass in arms and legs.

Swollen abdomen: this is due to fatty liver and increased capillary permeability resulting in ascites.

Peripheral edema: results from decreased oncotic pressure.

Anemia

A desquamative rash is seen on the flexures and the buttocks.

Skin pigmentation

Thinning of hair

Failure to gain body weight

Retarded growth

Lethargy or apathy

Behavioral changes such as irritability. Victims are apathetic and miserable. Physicians believe that return of a smile is the first sign of response to treatment.

Inability to fight infections due to poor immunity

Change in hair color

Diarrhea

Edema: Initially, it involves the dorsum of the feet and ankles and later spreads upwards to involve the whole body. Edema accounts for 5 – 20% of the body weight. Loss of fluid can mark a striking change in appearance.

Shock is seen in later stages

Loss of teeth

Anorexia

Red baby appearance due to discoloration of hair and skin

Poor renal functions

Metabolic and electrolyte imbalance

Diagnosis of kwashiorkor

The physical examination shows a general swelling, a protruded belly, and hepatomegaly. Investigations may include:

- Arterial blood gas
- Total protein levels
- Urinalysis
- Serum potassium
- Creatinine clearance
- Serum creatinine
- Blood urea nitrogen (BUN)
- Complete blood count (CBC)

Treatment of kwashiorkor

Treatment options depend on the severity of the condition. In the early stages of the disease, treatment revolves around providing an adequate diet for the child, with more calories and protein.

However, this will not compensate for the damage that has already been done to the growth and height potential of the victim. Carbohydrates, in the form of simple sugars and fats, are given first to cater for the catabolic needs. This is because the protein
Catabolism includes the urea cycle and this can overwhelm the already damaged liver.

So, **proteins** are given after other sources of energy have been provided. They serve only for the anabolic purpose. **Vitamins** and **minerals** are also essential to restore the nutritional status of the patient.

Food must be introduced slowly and gradually to prevent issues arising from the administration of high calories after a long period of time.

Patients of kwashiorkor may develop **lactose intolerance**. They require supplemental enzyme lactase.

Those in the later stages of the disease may present with **shock**. The treatment then aims to restore the blood volume and maintain blood pressure.

**Prognosis of kwashiorkor**

Early treatment can produce better results. Treatment in the later stages improves the nutritional status of the child; however, it does not compensate the physical and mental damage that has already been done. It can be a **life-threatening condition** if not treated on time.

**Possible complications of kwashiorkor**

If not treated on time, following complications are seen:

- Coma
- Permanent mental and physical disability
- Shock

**Prevention of kwashiorkor**

An **adequate diet** containing enough carbohydrates, fats that must provide 10% of the total caloric needs and proteins that make up for the 15% of the caloric intake. Proteins can be found in the following foods:

- Seafood
- Peas
Nuts
Seeds
Eggs
Lean meat
Beans

Marasmus

Marasmus is a type of malnutrition primarily caused by a deficiency in calories and energy. There is a severe deficiency of nearly all nutrients, especially protein, carbohydrates and lipids.

Distribution of marasmus

It is commonly seen in the following areas:

- Famine-stricken
- Urban slums and shanty towns of the third world countries
- Greater illiteracy rate countries

Causes of marasmus

Negative energy balance causes marasmus. This can be due to factors such as:

- A decreased energy intake
- An increased loss of ingested calories due to emesis, chronic diarrhea, burns, etc.
- An increased energy expenditure
- Viral, bacterial and parasitic infections
- Bottle feeding
- Combinations of the above factors

Pathophysiology of marasmus

In response to a low caloric diet and low energy, the body responds in the following ways:

- **Fat stores** decrease up to 5% of the total body weight.
- **Extracellular water** content of the body increases.
- **Protein mass** decreases up to 30% in the case of severe muscle fibers loss striations and become thin. Protein sparing mechanisms redirect amino acids to the vital organs.
- **Hypothermia** and **hypoglycemia** in infants is more frequent due to underdeveloped systems.
- **Potassium deficiency** of up to 15 mEq/kg resulting in hypotonia and impaired cardiac function.
- Elevated levels of **intracellular sodium** in muscles, brain and blood cells.
- Metabolic adaptions in marasmus are similar to those in starvation.
- **Basal metabolic rate** decreases. The energy is diverted from muscles to the vital organs. **Muscle loss** is a result of decreased energy expenditure.
- Brain, skeleton and kidney are preserved, whereas the liver, heart, pancreas and digestive tract are first affected.
- **Impaired glucose clearance** in marasmus is due to compromised pancreatic beta cell function.
- Secretory functions of mucosal surfaces are impaired, **decreased HCL production** and **slow peristalsis**.
- Adaptations are seen by thyroid hormones, insulin and growth hormone.
- Thymus and all other T lymphocyte-producing tissues are affected. This leads to **immunocompromised state**.
- The brain is usually preserved during marasmus.
- **Myofibril contractility** is impaired.

**Signs and symptoms of marasmus**

*Image: “A shrunken wasted appearance is a characteristic feature in marasmus.” Photo Credit: Content Providers(s): CDC/ Don Eddins - This media comes from the Centers for Disease Control and Prevention’s Public Health Image Library (PHIL), with identification number #1702. License: Public Domain*

A **shrunken, wasted appearance** is the classical presentation of marasmus. Other clinical manifestations are as follows:

- Prominence of ribs
- Slow growth
- Drastic loss of adipose tissue
- Chronic diarrhea
- Muscle atrophy, especially in the upper arms and buttocks
- Skin folds
- “old man” face
- Unusual body temperature (**hypothermia** or **pyrexia**)
- Anemia
- **Dehydration** (frequent thirst and shrunken eyes)
- Corneal lesions due to **vitamin A deficiency**
- Dermal manifestations
- Otitis and rhinitis
- **Hypovolemic shock** leading to weak radial pulse, cold extremities and decreased consciousness
- Tachypnea
- Paralysis of the lower extremities
- Poor bladder and bowel control
- Blood or mucous in stools
- Metallic bowel sounds
- Infections
- Weight loss
- Lethargy
- Fainting or alteration of awareness
- Persistent vomiting

Complications of marasmus

- Lack of proper growth in children
- Permanent vision loss
- Organ failure
- Severe weakness
- Joint deformities

Diagnosis of marasmus

Lab values are taken to construct an appropriate treatment plan. Diagnosis is based on the following lab tests:

- **Blood glucose**: lower than 3 mmol/L values are indicative of hypoglycemia.
- **Hemoglobin**: a level lower than 40 g/L is indicative of severe anemia.
- **Examination of blood smears** by microscopy: parasite detection is indicative of infection.
- **Albumin**: It gives an idea to the prognosis. Albumin value lower than 35 g/L is indicative of severe protein synthesis impairment.
- Urine examination and culture.
- Microscopic stool examination.
- **Electrolytes**: Hyponatremia is evident. However, results are rarely helpful and can also lead to inappropriate therapy.
- **HIV test**: not routinely performed.

Treatment of marasmus

- **Correction of water and electrolyte balance**. The following rules should be followed:
  - Use a nasogastric tube
  - Continue breastfeeding as soon as possible. However, in case of shock and coma, this is contraindicated
  - Start other food after 3 – 4 hours of rehydration
- **Treat infections**
- **Dietary support**
  - Vitamins and mineral supplements
  - 3-4 g protein and 200 cal/kg body weight/day
- Counsel parents and plan the future, including immunization and diet supplements
- Add frequent small feeds
- Use liquid diet
- Prevention of hypothermia
- Give vitamin A and folic acid
- Use lactose-free or soya bean formula for treating diarrhea
- Treat lactose intolerance
- In the cases of shock, intravenous rehydration with a Ringer-lactate solution with 5% dextrose is recommended
- Encourage the child to eat frequently
- Stimulate the emotional and physical development

Prevention of marasmus

- A diet rich in calories, proteins and other dietary essentials should be provided to the pregnant and lactating mother, and children
- Encourage breastfeeding
- Nutritional education
- Early treatment for affected children
- Immunization against major six killer diseases

References

Marasmus via medscape.com
Kwashiorkor via medlineplus.gov
What you should know about Marasmus via healthline.com

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