Malabsorption

By: Nimish Vakil, M.D., F.A.C.P., F.A.C.G., A.G.A.F., F.A.S.G.E., Division of Gastroenterology, Aurora Wilkinson Medical Clinic, Summit, WI, and Clinical Professor, University of Wisconsin School of Medicine and Public Health, Madison, WI and Carol Jorgensen-Vakil, M.S., R.D., C.N.S.D., Clinical Dietician, ProHealth Care, West Wood Health and Fitness Center, Pewaukee, WI

International Foundation for Gastrointestinal Disorders (www.iffgd.org)

Malabsorption refers to decreased intestinal absorption of carbohydrate, protein, fat, minerals or vitamins. There are many symptoms associated with malabsorption. Weight loss, diarrhea, greasy stools (due to high fat content), abdominal bloating and gas are suggestive of malabsorption. Vitamin and mineral deficiencies resulting from malabsorption may cause glossitis (sore tongue), cheilosis (a fissuring and dry scaling of the surface of the lips and angles of the mouth), and anemia. Chronic diarrhea is often the first symptom prompting one to seek medical evaluation, although diarrhea need not be present for one to have malabsorption. Steatorrhea, or fatty stools, is indicative of malabsorption. Stools will be frothy, foul smelling, and a ring of oil may be left on the toilet water.

The gastrointestinal tract and liver play key roles in the digestion, absorption and metabolism of nutrients. Diseases of the gastrointestinal tract and liver may profoundly disturb normal nutrition. An understanding of the anatomy of the gastrointestinal tract as well as the role each major segment plays in the digestion and absorption of food will help one understand the causes of malabsorption and shed light on the rationale for specific treatment regimens. In order for food to be absorbed, it must first be digested. Digestion is the mechanical and chemical process by which food is prepared for absorption. After a meal, food must first be broken down into simpler substances that can pass through the cells of the small intestine into the blood which transports them to all the cells of the body. The cells of the body can utilize these simpler substances as a source of energy. Digestion converts dietary protein into simple amino acids, dietary fats into fatty acids and monoglycerides, and starch into glucose.

Anatomical and physiological considerations

Digestion of food begins in the mouth where through the mechanical action of chewing and the chemical action of enzymes found in saliva, a bolus of food is formed and then passes through the esophagus. Contraction of the muscles in the esophagus moves the food bolus into the stomach by a process called peristalsis. Once in the stomach, the food is broken down further by strong contractions which expose it to gastric juices including hydrochloric acid and digestive enzymes which are secreted by glands in the lining of the stomach. The food is eventually converted into a liquid material called chyme which is then passed into the first part of the small intestine, the duodenum. The intestine is where food is eventually absorbed. In the intestine, the presence of chyme stimulates the production and release of a variety of enzymes from the pancreas and small intestinal glands.

Each enzyme has a specific role in digestion. There are special enzymes that digest protein into amino acids, starch into glucose and fat into fatty acids. The liver produces a substance called bile which helps to digest fat. Bile is formed in the liver, stored in the gallbladder and released into the small intestine as needed. The small intestine is about 23 feet long in the adult and has three segments. The duodenum is the first part of the small intestine and is about 10 inches long. The jejunum is the middle segment of the small intestine and is about 8 feet long. The last portion of the small intestine, the ileum, is about 12 feet long. The absorptive surface of the small intestine is greatly enhanced by the numerous folds and finger-like projections called villi and microvilli. It has been estimated that given all the folds, villi and microvilli, the total absorptive surface of the small intestine is about the size of a half of a basketball court!

Absorption of nutrients takes place all along the intestine, but each segment of the intestine absorbs only certain nutrients. Carbohydrates are ingested primarily in the form of starch or carbohydrates, sucrose (table sugar), fructose (fruit sugar) and lactose (milk sugar). The suffix "ose" refers to a form of carbohydrate. Salivary and pancreatic amylase (digestive enzymes) break up the starch into long chains of sugars called oligosaccharides and shorter chains called disaccharides and trisaccharides. Most starch hydrolysis (breaking up a molecule into its smaller components) occurs in the duodenum and absorption takes place in the duodenum and jejunum. Specific enzymes that hydrolyze disaccharides (disaccharidases) into their simplest forms or monosaccharides are located along the small intestine microvilli. Once the sugar is in the form of a monosaccharide, it can then be absorbed into the blood. Carbohydrate malabsorption occurs in pancreatic disease, in selective deficiency of disaccharidases such as lactase (digests lactose) or sucrase (digests sucrose), in disorders of small intestinal cell function such as sprue or regional enteritis, and in loss of intestinal mucosal surface which occurs after resection of

bowel. Abdominal distention, bloating and gas may be signs of carbohydrate malabsorption.

Proteins are broken down into long chains of amino acids by pancreatic enzymes. Small intestinal enzymes activate the pancreatic enzymes so that digestion and absorption of protein can take place. Absorption of amino acids and peptides occurs in the duodenum and jejunum. Dietary fat is normally absorbed in the duodenum and jejunum. Before fat can be absorbed, however, it must first be made into a water-soluble form. Broken down dietary fats combine with bile salts and phospholipids (substances present in bile from the liver) to form a packet called a micelle. The micelle is water-soluble and is easily absorbed in the duodenum and jejunum. Large amounts of water are involved in digestion and must be recycled in order to prevent dehydration. Water is reabsorbed in the large intestine. From the large intestine, water goes back into the bloodstream and the waste passes into the rectum and out the anus.

Tests for malabsorption

There are several tests that can be performed to help diagnose malabsorption.

Blood tests – These can be used to identify suspected malabsorption and are usually the first tests done. They are not specific because low levels of certain substances could be due to disorders other than malabsorption e.g. an unusual diet. Blood carotene levels are useful to screen for malabsorption. Low levels of carotene in the blood suggest deficient absorption of fat-soluble vitamins or dietary deficiency. Serum carotene levels are generally low in people with fat malabsorption. Vitamin B12 and folate levels may also be used to screen for malabsorption. There are numerous causes of folate and B12 deficiency, and since the deficiencies often occur together and cause similar types of anemia, both must be measured to ensure proper diagnosis. Low calcium levels may result from either malabsorption of vitamin D or to binding of calcium to unabsorbed fatty acids. Vitamin K deficiency resulting from malabsorption may cause bleeding disorders. Anemia due to iron deficiency may be caused by malabsorption of iron in the first part of the small bowel. Normal levels of carotene, vitamin B12, folate, iron, calcium, phosphorus, albumin, and protein suggest that malabsorption is not a significant problem.

Another type of blood sampling can be used to test absorption. A substance can be administered orally and its concentration is then measured in the blood to provide a measure of absorptive capacity. The most commonly used test is the D-xylose test. A sugar called xylose is given orally and then measured in the blood 2 hours later.

Stool tests – Tests of the fat content of stool may be used to determine if fat malabsorption is present. Stool is collected over a period of 72 hours with the person consuming a diet containing 100g of fat per day. If the amount of fat in the stool is high, it suggests that the body is not absorbing fat.

Breath tests – Breath tests are another method of detecting malabsorption. They are most often performed to test for lactose intolerance. Lactose is given by mouth and the subject's breath is analyzed for the presence of hydrogen gas. If lactose is being malabsorbed, colonic bacteria will work on the lactose to produce hydrogen gas which will be exhaled by the patient and measured in his or her breath.

Other tests – Tests such as biopsies of the small intestine (usually performed using an endoscope passed through the mouth into the intestine) are used to diagnose certain malabsorptive conditions. Special tests to image organs such as the pancreas are also useful in some cases.

Specific malabsorptive states

Lactose Intolerance – Perhaps the most common malabsorptive state is due to lactose malabsorption. This is a genetically determined condition and affects many individuals of African or Asian descent. In these persons, the body lacks an enzyme to digest lactose, a sugar present in milk, and bloating and diarrhea can result. The enzyme may be totally absent or present in reduced amount so that symptoms may vary depending on the amount of lactose ingested. The amount of the enzyme decreases with age and some people first notice symptoms when they reach their twenties. Dairy products are an important source of calcium and this should be considered in planning diets for lactose-intolerant subjects. Lactose intolerance is widespread and under-diagnosed. Recognizing this condition and using milk treated with enzymes to pre-digest the lactose or taking enzyme tablets with dairy products can correct symptoms related to this condition.

Small intestinal disease – Surgical resection or diseases of the small intestine may result in varying degrees of malabsorption depending on the site of resection or disease. Diseases involving the duodenum may be associated with lactose intolerance, poor tolerance of concentrated sugars, and decreased absorption of iron and calcium. Almost all nutrients are usually absorbed in the first three to five feet of the bowel. The absorption of most minerals especially iron, calcium and zinc, as well as most vitamins occurs in the upper part of the small intestine. Resections of the lower parts of the small intestine (ileum) may result from surgical intervention for Crohn's disease. The ileum plays a major role in reabsorption of bile salts, substances produced by the liver to help digest fats that are recycled by the body for use with future meals. The ileum is also important in vitamin B12

absorption. If bile salts are not absorbed properly, the amount of these substances in bile falls and fats and fat soluble vitamins (A,D,E,K), cannot be properly absorbed. A further problem is that if bile salts reach the colon, they can cause large amounts of fluid to be secreted causing watery diarrhea. If large portions of the bowel are lost to surgical resection, rapid transit of nutrients through the remaining bowel occurs, causing malabsorption.

Pancreatic disease – Diseases of the pancreas can cause severe malabsorption of fats and carbohydrates. Symptoms depend on the severity of the condition but diarrhea with greasy, foul smelling stools is common and weight loss can be profound.

Liver and biliary disease – In conditions when insufficient bile reaches the intestine, fats are not absorbed and again diarrhea and weight loss occur. Vitamins that are absorbed with fats are also affected and vitamin D deficiency can occur.

Treatment

When the cause of malabsorption is treatable, the primary goal of treatment is to treat the cause. In patients who cannot be completely restored to normal (for example after extensive surgical removal of the intestine), special dietary measures need to be adopted. Dietary treatment will also depend on the site of malabsorption. If fat is being malabsorbed, a low fat diet should be consumed. Certain oils called medium chain triglyceride oils are easier to absorb in certain disease states and may be helpful as a calorie supplement.

For carbohydrate malabsorption, disaccharides, specifically lactose, often must be restricted. This involves limiting milk products or choosing many of the low lactose products now available. Lactase enzyme tablets may also be taken with milk products to digest the lactose. Vitamin and mineral supplementation needs to be tailored to individual needs, based upon serum levels, and clinical symptoms. Pancreatic enzymes are available in capsules or tablets and in combination with a low fat diet may benefit the patient with pancreatic disease. For the patient with severe malabsorption, in whom dietary measures are not feasible, feeding can be administered intravenously.

A perspective

Occasional diarrhea and bloating are not causes for alarm in most cases. Certain food substances contain materials that humans cannot digest well and they cause bloating and gas (beans, cabbage). This is not a sign of malabsorption. However, persistent diarrhea, weight loss, greasy stools and signs of vitamin deficiency (sore tongue etc.) should prompt further attention.