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Digestion in the Mouth and Stomach in the Early Postnatal Period

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Annotation. The morphofunctional features of the digestive system depend primarily on the type of nutrition and food composition. Adequate food for children of the first year of life, especially the first 4 months, is mother's milk. By the time of the birth of the child, the secretory apparatus of the digestive tract is formed according to milk feeding. The number of secretory cells and enzymatic activity of digestive juices are insignificant. The share of cavitary digestion is much less than in adults. In the first days and months, along with the cavity, an autolytic type of digestion is carried out by breast milk enzymes. The share of parietal and intracellular hydrolysis of proteins, fats and carbohydrates is about 80% of the total volume of digestion.

Keywords. Salivary glands, digestion in the stomach, enzymes, bile excretion (cholekinesis).

Complementary feeding at 5-6 months ensures the further development of the digestive glands and their adaptation to the nature of the food.

Salivary glands.

The secretion of saliva in newborns outside the periods of feeding is very low, while sucking it increases to 0.4 ml / min.

Saliva contains the enzyme amylase, the activity of which is low, lysozyme, which has a bactericidal effect. The mucous glands of the tongue produce a small amount of lipase, mucin. The pH of saliva ranges from 6 to 7.8.

The role of saliva lies in the fact that it is a sealant of the child's oral cavity, providing, as it were, gluing the nipple to the oral mucosa, which creates the vacuum necessary for sucking. Saliva, mixed with milk, promotes the formation of looser casein flakes in the stomach.

In newborns, there is no conditioned reflex component in the regulation of saliva, salivation increases with the maturation of the sensory systems of the body and when feeding with mixed food. The secretion of saliva increases especially during periods of teething. Children of the first year of life do not know how to swallow saliva, so they often have physiological salivation.

The enzymatic activity of saliva increases by 6 months and reaches a maximum in the period from one to four years.

Digestion in the stomach.

The newborn has a well-developed cardiac section of the stomach, worse pyloric. The fundus of the stomach and the pyloric part develop sufficiently only by 10-12 years.

The entrance to the stomach is wide, the cardiac sphincter is poorly developed, but the muscular layer of the pylorus is expressed, so regurgitation and vomiting are often observed in infants. The capacity of the stomach of a newborn is 40-50 ml, by the end of the first month 120-140 ml, by the end of the first year 300-400 ml.

In the gastric mucosa there are the same glands as in adults, but the number of secretory cells is 10-12 times less than in adults, the glands are shorter and wider.

In infants, the volume of gastric juice is not large, because. the cerebral phase of gastric secretion is poorly expressed, the receptor apparatus of the stomach is poorly developed, mechanical and chemical effects do not have a pronounced stimulating effect on the secretion of the glands.

The pH of the gastric contents of a newborn baby ranges from slightly alkaline to slightly acidic. During the first day, the environment in the stomach becomes acidic (pH 4-6). The acidity of the gastric juice is created not by HCl (free HCl in the juice is negligible), but by lactic acid.

Activation of proteolytic enzymes is carried out mainly by lactic acid.

In the slightly acidic environment of the stomach of young infants, proteases are inactive, due to which various immunoglobulins are not hydrolyzed and absorbed in the intestine in a native state, providing the proper level

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of immunity. Pepsinogens are activated by lactic acid. In the stomach of a newborn, 20-30% of the incoming proteins are digested.

Under the influence of saliva and gastric juice in the presence of calcium ions, caseinogen protein dissolved in milk, lingering in the stomach, turns into insoluble loose flakes, which are then exposed to the action of proteolytic enzymes.

Gastric lipase breaks down only emulsified milk fats; breast milk lipase is activated by lipokinase in the baby's gastric juice.

In the slightly acidic environment of the stomach, the amylolytic activity of the saliva of the child and mother's milk can be preserved.

During breastfeeding, gastric juice is less acidic, with less enzymatic activity than when fed with cow's milk and nutrient mixtures. With the transition to a mixed diet, the pH gradually decreases and reaches the values of adults only by 7-12 years.

The duodenum is a kind of center for regulating the functions of the digestive system. Removal of the duodenum in the experiment leads to cachexia (exhaustion) of animals, many of them die. This is due to the shutdown of its endocrine function. Gastrointestinal hormones secreted by the proximal small intestine regulate not only the digestive processes, but also significantly affect the absorption and deposition of nutrients, regulate food intake and metabolism.

Food entering the small intestine is exposed to the action of pancreatic juice, bile and its own intestinal juice. The pancreas secretes all kinds of enzymes: proteases, among which there are endo- and exopeptidases; lipases, amylolytic enzymes, nucleases.

Proteases - trypsinogen and chymotrypsinogen are activated in the intestinal cavity by the enterokinase enzyme secreted by the mucosa of the small intestine. Enterokinase triggers the initial stage of trypsinogen activation, further activation of proteases is carried out by active trypsin (autocatalysis). Active trypsin, chymotrypsin, elastase (all endopeptidases) continue the hydrolysis of proteins that began in the stomach. The resulting peptides of varying complexity become a substrate for the action of aminopeptidases and carboxypeptidases A and B (exopeptidases). As a result of hydrolysis, free amino acids appear.

In the acinar cells of the pancreas, where trypsinogen is synthesized, there is also its inhibitor. It prevents the activation of trypsinogen in the cells and ducts of the gland that synthesize it, protecting them from self-digestion.

Pancreatic lipase is particularly effective in the presence of bile acids and calcium salts. This enzyme breaks down neutral fats to fatty acids (40%), di- and triglycerides (10%), monoglycerides (50%). Phospholipase A is secreted inactive, after activation it hydrolyzes phospholipids.

Amylolytic enzymes - □-amylase, maltase, sucrase break down animal and vegetable starch to glucosides, and then monosaccharides. Nucleases - ribonuclease and DNase - hydrolyze nucleic acids.

The mineral components of pancreatic juice are Na+, K+, Ca2+, Mg2+, Zn2+ cations and Cl-, HCO3- anions. The released bicarbonate neutralizes the hydrochloric acid coming from the stomach and creates an optimal alkaline environment for enzymes to work. Bicarbonate secretion is determined by the concentration of hydrogen ions in the duodenum. With an increase in the concentration of H + ions, the secretion of NaHCO3, especially HCO3-, increases, and the secretion of hydrochloric acid by parietal cells is simultaneously inhibited. juice pH 7.5-8.8.

The regulation of pancreatic secretion is conditionally divided into the same stages as the regulation of gastric juice secretion. The complex reflex phase indicates participation in the regulation of the central nervous system. After 2-4 minutes after the conditioned reflex effect or after the start of a meal, a small amount of full-fledged juice is separated. In the gastric phase, the secretion of juice continues to increase. Reflex regulation is associated with irritation of the stomach receptors and is based on excitation of the vagus nerve. Together with acetylcholine, a vasoactive intestinal polypeptide is released in the synapse, which stimulates the secretion of bicarbonate. Sympathetic fibers that innervate the exocrine cells of the pancreas inhibit secretion, but increase the synthesis of enzymes in them. Humoral regulation in the gastric phase is carried out by bombesin, serotonin - they activate secretion. Somatostatin, vasoactive intestinal peptide - inhibit.

Of great importance in the regulation of the secretion of pancreatic juice is the intestinal phase. In this phase, secretin and cholecystokinin (CCK) hormones are released in the duodenum and proximal small intestine.

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H+ ions are the strongest initiator of secretin release from S cells. The threshold pH for the secretion of this hormone is 4.5. Secretin causes copious secretion of juice with a high content of bicarbonates and a low content of enzymes.

CCK, on the contrary, stimulates the formation and excretion of enzymes, while the volume of juice decreases. The secretion of CCK is activated by intermediate products of the hydrolysis of proteins, fats, carbohydrates in the presence of Ca2+ ions, a decrease in pH in the duodenum. The combined effect of reflex and humoral regulation contributes to the fact that the amount of juice, its selective enzymatic activity, the duration of secretion correspond to the quality and quantity of the digested food components. 1.5-2.0 liters of juice is released per day.

The liver performs many important functions, one of which is the production of bile. Bile is secreted by hepatocytes (bile secretion), accumulates in the gallbladder and, as necessary, is excreted into the duodenum, first from the gallbladder, and then directly from the liver (biliary excretion).

The main components of bile are bile acids - chenodeoxycholic and cholic (primary), which in the liver attach to glycocol or taurine and are excreted as salts of taurocholic (20%) and glycocholic (80%) acids. The remaining free primary acids in the large intestine under the influence of anaerobic bacteria are converted into secondary acids - lithocholic and deoxycholic. With bile, the pigment bilirubin is excreted (a breakdown product of hemoglobin), which gives the liver bile a characteristic color, cholesterol, lecithin, Na +, K +, Ca2 +, Cl-, HCO3- ions; slime. bile pH - 7.8-8.2. Daily amount - 1.0 -1.8 liters.

Functions of bile:

1. Emulsifies fats and stabilizes emulsions due to bile acids, the molecule of which has a lipophilic group at one end, and a hydrophilic one at the other. Lipophilic ends penetrate into fat droplets, crushing them into small fragments, hydrophilic ends remain on the surface. Thus, a water-soluble emulsion is formed from the smallest droplets of fat surrounded by bile acids. The surface area for lipase exposure is greatly increased. Thus, bile enhances the action of pancreatic enzymes, especially lipase.
2. With the help of bile acids, lipids, fat-soluble vitamins are transported to enterocytes and triglycerides are resynthesised.
3. Bile acids contribute to the fixation of enzymes in the glycocalyx network.
4. Bile prevents the development of putrefactive processes in the intestines, because. taurocholic acid has a bactericidal effect.
5. Bile acids regulate bile formation and affect cholesterol metabolism.
6. Bile regulates secretion and, especially, motility of the small intestine.
7. With the help of bile, endobiotics (bilirubin, porphyrins, cholesterol, aging proteins and xenobiotics (drugs, heavy metals, toxins) are excreted.

Bile formation. Most of the bile acids (85-90%) that enter the intestine are absorbed into the blood, transported through the portal vein to the liver and included in the bile. The remaining acids are excreted from the body with feces and give it a brown color. Bile formation is carried out continuously, but its intensity changes due to reflex and humoral influences. The act of eating, irritation of the receptors of the gastrointestinal mucosa excite parasympathetic fibers and increase bile formation. Bile itself is a strong stimulant of bile formation. The more bile acids enter the portal circulation, the more they are included in the bile; the synthesis of bile acids is reduced. The deficiency of acids is replenished by increasing their synthesis. Increase the secretion of bile secretin (a lot of water and hydrocarbons), glucagon, CCK, as well as many foods. Excess bile is deposited in the gallbladder, where it is concentrated and mucin is added to it.

Bile excretion (cholekinesis). The secretion of bile into the duodenum is carried out by reflex and humoral mechanisms. Excitation of the vagus nerve increases the excretion of bile during conditioned and unconditioned reflexes. Significantly increases the excretion of bile hormone CCK, increasing the contraction of the gallbladder and relaxing the sphincters of the bile ducts. Fats, milk, egg yolks and meat activate bile excretion. Somatostatin, VIP (vasoinhibiting peptide) reduce cholekinesis.

For a day, an adult produces 1-1.8 liters of bile.

Digestion in the small intestine. In the small intestine, all types of digestion are observed - cavitary, parietal, membrane and intracellular (these processes have already been discussed above, on page 7).

Intestinal juice is a mixture of Lieberkühn and Brunner gland secretions and desquamated epitheliocytes. Epithelial cells, the growth zone of which is located in the crypt, gradually move from the base to the top of

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the villus and are rejected. For 3-6 days, the epithelium of the intestinal mucosa is completely renewed. Intestinal juice is a cloudy viscous liquid. When centrifuged, it is divided into liquid and dense parts. The liquid part contains organic substances: proteins, polypeptides, amino acids, urea and inorganic substances: chlorides, bicarbonates, sodium, potassium, calcium phosphates. pH of intestinal juice - 7.2-7.5. With intensive secretion, the pH reaches a value of 8.6. The dense part has a greater enzymatic activity, consists of destroyed enterocytes and their enzymes, mucus secreted by goblet cells. Up to 2.5 liters of intestinal juice is excreted per day in a person.

The hydrolysis of nutrients is completed in the intestine. There are more than 20 enzymes in the juice. The main part of enzymes takes part in parietal and membrane digestion. Peptidases (aminopolypeptidases, dipeptidases, etc.) break down the products of protein hydrolysis into amino acids. Lipolytic enzymes - lipase, phospholipase, cholesterolesterase complete the hydrolysis of lipids with the formation of fatty acids and monoglycerides. Monoglycerides are hydrolyzed by monoglyceride lipase. It breaks down monoglycerides of any hydrocarbon chain length, as well as di- and triglycerides. Amylases: - amylase, - amylase, lactase, sucrase, maltase - break down glucosides to glucose, galactose and fructose. Lactase (□-galactidase), maltase (□-glucosidase), sucrase, have a high substrate specificity. Genetically determined or acquired insufficiency of these enzymes causes intolerance to the corresponding disaccharide.

The juice contains nucleases and nucleotidases. RNA and DNA, formed after the hydrolysis of nucleoproteins by proteases, are hydrolyzed by RNA and DNases to oligonucleotides. The latter are exposed to the action of nucleases and esterases, resulting in the formation of nucleotides. Under the influence of alkaline phosphatase, nucleosides are formed from nucleotides, which are absorbed.

A small amount of monomers is formed in the intestinal cavity, a large number of them part is formed in the brush border, where they are immediately absorbed as they form.

Regulation of the secretion of intestinal juice is carried out by local nervous and humoral mechanisms. Irritation of the intestinal mucosa by chyme and, especially, by food hydrolysis products, increases secretion. At the same time, a selective increase in enzymatic activities is observed when the mucosa is exposed to various food components. For example, a long diet with a predominant content of carbohydrates increases amylolytic activity, an increase in fat in the diet increases the activity of lipases, that is, enzymatic adaptation to substrate substances occurs. The hormones GIP, VIP, motilin stimulate secretion, the mucosal hormone enterocrinin increases secretion by 3-5 times; somatostatin - inhibits.

Colon.

Digestion products come here, from which nutrients are almost completely extracted with the help of their own enzymes. Therefore, the enzymatic activity of colonic juice is low. The juice contains lipase, peptidases, alkaline phosphatase, which hydrolyzes desquamated epitheliocytes. Juice is released in small quantities. Mechanical irritation of the mucosa greatly increases secretion. The large intestine receives dietary fiber - polysaccharides of plant origin. Dietary fiber hydrolysis occurs with the help of symbiont bacteria. The intestinal microflora is represented by bifidobacteria and bacterioids (90% of all microbes); lactobacilli, enterococci (10%); the remaining bacteria account for less than 1% (staphylococci, aerobic bacilli, yeast). Populations of closely interacting bacteria play an important role in the life of a macroorganism:

1. influence the structural characteristics of the intestine (microbial-free animals have less intestinal mass, thinner wall, reduced mitotic activity of epithelial cells),
2. determine the body's immune defense, stimulating its development; populations of normal microflora inhibit the development of pathogenic microbes,
3. have an enzymatic effect on food residues and fibers, mainly in the large intestine, resulting in the formation of essential amino acids, vitamins (K, E, B6, B12), lactic and succinic acids and other compounds (secondary nutrients).
4. secrete biologically active substances that have a regulatory effect on the body (for example, serotonin, histamine, etc.).

inactivate intestinal enzymes and hydrolyze them, supplying an additional amount of amino acids to the body.

The normal ratio of different types of microflora (eubiosis) and its abundance depend on many endogenous and exogenous factors. Endogenous factors include the composition of digestive juices (the content of saliva lysozyme, acidic environment in the stomach, bile have bactericidal properties). Food hydrolysis products are important, which can either suppress or enhance microflora.

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Exogenous factors are, first of all, the composition of food. An increase in the diet of plant foods contributes to the development of certain types of bacteria, while fermentation processes increase in the colon. With excessive consumption of animal proteins, the development of another type of bacteria increases and the processes of putrefactive decomposition of food increase.

Thus, with an unbalanced diet, dysbacteriosis develops. A balanced diet balances the processes of fermentation and decay: thus, as a result of fermentation, an acidic environment is created that prevents decay. Exogenous factors include the introduction into the body of antibacterial drugs that suppress the microflora.

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