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FUNCTIONAL FEATURES OF PANCREATIC SECRETORY ACTIVITY AND CHANGES IN ENZYME HOMEOSTASIS DURING HYPOKINESIA

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Abstract

The exocrine function of the pancreas is an important component of the digestive system and is controlled by complex neurohumoral mechanisms. The intensity and qualitative composition of pancreatic secretion are influenced by hormonal, neural, nutritional, and pathological factors, as well as the body's level of motor activity. The impact of hypokinesia, associated with a modern lifestyle, on the functional state of the pancreas has received particular attention in recent years. This article analyzes the main mechanisms regulating pancreatic secretion and examines the role of hypokinesia as a modifiable risk factor for digestive disorders.
Keywords: pancreas, exocrine secretion, hypokinesia, neurohumoral regulation, digestive system.

Introduction

The pancreas occupies a central position in the digestive system, providing enzymatic processing of essential nutrients. Exocrine pancreatic insufficiency is one of the causes of maldigestion syndrome and is common in various somatic and metabolic disorders. With decreased physical activity, typical of urbanized societies, the importance of hypokinesia as a factor influencing the functional state of the gastrointestinal tract increases. However, the mechanisms of its effect on pancreatic secretion have been insufficiently studied, which determines the relevance of this study.

Materials and Methods (Review)

This study utilized an analytical method, summarizing data from experimental and clinical studies on the physiology of pancreatic secretion and the influence of various exogenous and endogenous factors on its regulation. Publications by Russian and international authors devoted to neurohumoral regulation, the impact of lifestyle, and hypokinesia on the digestive organs were analyzed.

Research Objectives. The primary objective of the study is to elucidate the following current and unresolved issues:

- To study pancreatic enzyme secretion activity and blood hydrolytic enzyme activity in intact rats.

- To determine the effect of gamma radiation doses (1, 2, 4, 6) on pancreatic enzyme secretion.

- To study the effect of hypokinesia of varying durations with gamma radiation (4 Gray) on enzyme homeostasis.

The exocrine function of the pancreas is realized through the secretion of pancreatic juice containing digestive enzymes (amylase, lipase, proteases) and bicarbonates. Secretion is carried out by acinar and ductal cells and has a phasic nature (cephalic, gastric, and intestinal phases). Optimal functioning of the gland depends on adequate blood supply, nervous regulation and hormonal balance.

Neurohormonal Regulation

Parasympathetic innervation via the vagus nerve stimulates exocrine secretion, while sympathetic activation inhibits it. Humoral regulation is mediated by gastrointestinal hormones, the most prominent of which are secretin and cholecystokinin. Secretin stimulates bicarbonate secretion, while cholecystokinin stimulates the enzymatic activity of acinar cells.

Influence of Dietary and Metabolic Factors

The qualitative composition of food determines the nature of pancreatic secretion. Fats and proteins are the most potent stimulators of enzymatic activity, while carbohydrates have a less pronounced effect. Metabolic disorders, including obesity and insulin resistance, can alter the sensitivity of the pancreas to regulatory signals. The Effect of Hypokinesia on Pancreatic Secretion

Hypokinesia is accompanied by a decrease in overall metabolic activity, disruption of the autonomic balance, and slower gastrointestinal motility. Reduced parasympathetic nervous system tone due to insufficient physical activity leads to a decrease in the stimulating effect of the vagus nerve on the pancreas.

Furthermore, hypokinesia contributes to the deterioration of regional blood circulation, which negatively impacts acinar cell nutrition and enzyme synthesis. Experimental studies show that prolonged limited physical activity is accompanied by a decrease in pancreatic enzyme secretion and a change in their qualitative composition. These changes may contribute to the development of functional exocrine pancreatic insufficiency and digestive dysfunction.

Materials and Methods: Experiments were performed on white, outbred male laboratory rats weighing 180-200g. Total irradiation of rats with 60Co γ-rays was performed using the Luch device. The irradiation field size was 20 x 20 cm, and the skin focal length was 75 cm. The dose rate varied between 0.86 and 0.85 Gy/min. Absorbed doses were 1, 2, 4, and 6 Gray. Enzyme activity in pancreatic tissue homogenate and serum was measured on days 1, 3, 7, 10, 20, 30, 45, and 60 after irradiation. Intact rats not exposed to any treatment served as a control.

Discussion of Results. The results showed that amylolytic activity was most pronounced in rat pancreatic homogenate: 1460±56.0 U/g. This enzyme, synthesized by acinar cells, hydrolyzes the α-1-4-glucosidic bonds of polysaccharides. The hydrolysis of polysaccharides, initiated in the stomach by salivary carbohydrases, is vigorously continued by pancreatic α-amylase and culminates in several intestinal disaccharides.

Total proteases are the second most active enzyme in rat pancreatic homogenate, at 230.0 ± 6.1 U/g. Proteolytic enzymes are synthesized and secreted by acinocytes in an inactive, zymogenic form as trypsinogens, chymotrypsinogens, procarboxypeptidases, and proelastases.

Lipase activity in rat pancreatic homogenate is much lower than that of the preceding enzymes, at 70.1 ± 3.1 U/g. This enzyme is synthesized and secreted by acinocytes in an active state. Pancreatic lipase is the primary and essentially the only lipolytic enzyme that breaks down dietary triglycerides, which make up 90% of dietary fat consumed by humans.

Our results for rat blood enzymes show that amylase activity is quite high, equal to 560.0±11.0 U/ml. In the blood, lipolytic activity is much lower (16.0±0.2 U/ml) than amylolytic activity.The pattern of amylase and lipase activity observed in pancreatic homogenate is replicated in the blood.

Conclusion

The rat pancreas contains enzymes that hydrolyze virtually all macronutrients—proteins, lipids, and carbohydrates. Their ratios vary within pancreatic tissue. Enzymes with amylolytic activity are most abundant, followed by proteolytic activity, and lipolytic activity is the least abundant. The amylase and lipase levels in the blood are much lower than in pancreatic tissue.

Exocrine pancreatic secretion is the result of the interaction of multiple regulatory factors. Along with traditionally studied hormonal and neural mechanisms, hypokinesia represents a significant and potentially modifiable factor influencing pancreatic function. Considering physical activity levels can be important in the prevention and treatment of digestive disorders.