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ADRENALINE-INDUCED MORPHOFUNCTIONAL AND IMMUNOHISTOCHEMICAL CHANGES IN THE PANCREAS OF EXPERIMENTAL RATS

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Abstract

Background

Chronic activation of the sympathoadrenal system plays an important role in the development of pancreatic dysfunction. However, morphological mechanisms underlying endocrine and exocrine pancreatic adaptation to prolonged adrenaline exposure remain insufficiently investigated.

Objective.*To evaluate morphological, morphometric, and immunohistochemical changes in the pancreas of rats subjected to prolonged adrenaline-induced stress.*

Keywords: *pancreas, adrenaline stress, Ki-67, BCL-6, morphometry, immunohistochemistry, endocrine adaptation.*

Methods

Pancreatic tissues from control and adrenaline-treated rats were examined using hematoxylin-eosin staining and immunohistochemical analysis with Ki-67 and BCL-6 markers. Morphometric analysis was performed using QuPath software. Statistical analysis included Student's t-test with significance accepted at $p<0.05$.

Results

Adrenaline exposure induced significant hypertrophy and hyperplasia of the islets of Langerhans. Nuclear volume increased from 14.16±0.69 μm² to 23.76±2.31 μm² ($p<0.01$), while cytoplasmic volume increased from 36.3±1.47 μm² to 54.9±2.76 μm² ($p<0.01$). BCL-6 expression increased from 12.3±1.4% to 42.4±6.1% ($p<0.001$), and Ki-67 expression increased from 10.1±1.2% to 36.72±4.15% ($p<0.001$). Exocrine tissue demonstrated vacuolization, edema, vascular congestion, ischemic alterations, and lymphocytic infiltration.

Conclusions

Prolonged adrenaline stress causes biphasic pancreatic remodeling characterized by compensatory activation of endocrine proliferation and anti-apoptotic mechanisms followed by progressive dystrophic changes in exocrine tissue.

1. Introduction

Stress-induced activation of the hypothalamic-pituitary-adrenal axis and sympathoadrenal system contributes significantly to metabolic disorders. Persistent elevation of catecholamines disrupts glucose homeostasis and increases pancreatic functional load.The pancreas is particularly vulnerable to prolonged adrenergic stimulation because both endocrine and exocrine compartments participate in adaptation to stress-induced metabolic demands. Despite numerous studies investigating stress physiology, morphofunctional mechanisms underlying pancreatic adaptation remain incompletely understood.

The present study aimed to investigate structural and immunohistochemical changes in pancreatic tissue following prolonged adrenaline exposure in rats.

2. Materials and Methods

Experimental Design

Experimental study was performed on laboratory rats divided into:

Control group

Adrenaline stress group

Histological Examination

Pancreatic tissues were fixed in formalin, embedded in paraffin, sectioned at 3–4 μm thickness and stained with hematoxylin-eosin.

Immunohistochemistry.

Immunohistochemical staining was performed using antibodies against:

Ki-67 (proliferation marker)

BCL-6 (anti-apoptotic regulatory marker)

Expression intensity and percentage of positive cells were evaluated according to standard scoring systems.

Morphometric Analysis

Digital image analysis was performed using:

QuPath 5.0

R Studio

Python-based image processing

Parameters evaluated:

Nuclear volume

Cytoplasmic volume

Total cell volume

Nuclear-cytoplasmic ratio

Islet area

Cell number

Statistical Analysis

Data were analyzed using Student's t-test. Results were expressed as mean ± SD. Statistical significance was accepted at $p<0.05$.

3. Results

Histological Changes

Control animals demonstrated preserved pancreatic architecture with normal acini and islets of Langerhans. No inflammatory or degenerative alterations were observed.

In contrast, adrenaline-treated animals exhibited:

Enlargement of Langerhans islets

Endocrine cell hypertrophy

Perivascular edema

Functional hyperemia

Venous congestion

Acinar vacuolization

Steatotic changes

Lymphocytic infiltration

Morphometric Changes

Significant increases were observed in endocrine cells:

Parameter	**Control**	**Adrenaline**
Nuclear volume	14.16±0.69	23.76±2.31
Cytoplasmic volume	36.3±1.47	54.9±2.76
Total cell volume	50.46±1.59	78.66±2.55
N/C ratio	0.39±0.037	0.44±0.051

All changes were statistically significant ($p<0.05$–0.01).

Immunohistochemical Findings

BCL-6 Expression

BCL-6 expression increased significantly:

Control: 12.3±1.4%

Adrenaline: 42.4±6.1% ($p<0.001$)

Ki-67 Expression

Ki-67 positive nuclei markedly increased:

Control: 10.1±1.2%

Adrenaline: 36.72±4.15% ($p<0.001$)

4. Discussion

The findings demonstrate pronounced pancreatic remodeling during prolonged adrenaline stress.

Hypertrophy and hyperplasia of islet cells likely represent compensatory mechanisms aimed at maintaining glucose homeostasis under conditions of persistent catecholamine stimulation.

Increased Ki-67 expression indicates activation of proliferative pathways within endocrine pancreatic tissue. Simultaneously, elevated BCL-6 expression suggests stimulation of anti-apoptotic mechanisms that support cell survival during stress exposure.

However, the exocrine pancreas displayed evidence of progressive injury characterized by vacuolar degeneration, ischemia, edema, and inflammatory infiltration. These findings suggest that prolonged compensatory activation ultimately results in structural deterioration.

The observed biphasic response corresponds with contemporary concepts of stress-induced organ remodeling, where adaptive changes are followed by exhaustion and tissue damage.

5. Conclusions

Prolonged adrenaline exposure induces significant morphofunctional remodeling of the pancreas.

Endocrine tissue demonstrates compensatory hypertrophy and hyperplasia.

Ki-67 expression increases 3.6-fold, indicating enhanced proliferative activity.

BCL-6 expression increases 3.4-fold, reflecting activation of anti-apoptotic pathways.

Exocrine pancreatic tissue undergoes dystrophic, ischemic, and inflammatory changes.

Adrenaline stress produces a biphasic adaptive–degenerative pattern of pancreatic response.

References

1. Selye H. Stress and the General Adaptation Syndrome.
2. McEwen BS. Protective and damaging effects of stress mediators.
3. Eizirik DL et al. The pancreatic beta-cell in stress adaptation.
4. Donath MY. Inflammation and pancreatic dysfunction.
5. Bonner-Weir S. β-cell growth and regeneration.
6. Ashcroft FM. Glucose sensing in pancreatic β-cells.
7. American Diabetes Association Standards of Care.
8. Saisho Y. β-cell adaptation and failure.
9. Robertson RP. Oxidative stress and β-cell dysfunction.
10. Rorsman P. Pancreatic endocrine physiology.