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COMPARATIVE MORPHOMETRIC ANALYSIS OF THE PROSTATE GLAND IN NORMAL CONDITIONS AND UNDER ENVIRONMENTAL STRESS-INDUCED NEPHROLITHIASIS

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Abstract. The prostate gland is an essential organ of the male reproductive system, playing an important role in the production of prostatic secretions and maintaining reproductive function. Its structural organization is closely related to hormonal regulation, metabolic activity, and the physiological condition of the urinary system. Nephrolithiasis is a pathological condition characterized by the formation of mineral deposits in the kidneys and urinary tract. Environmental stress factors, including exposure to unfavorable environmental conditions, toxic substances, and oxidative stress, may contribute to the development and progression of nephrolithiasis. In addition to renal damage, these pathological processes may potentially influence the morphological condition of other organs of the urogenital system, including the prostate gland. The present study focuses on the comparative morphometric assessment of prostate gland tissue under normal physiological conditions and during experimentally induced nephrolithiasis associated with environmental stress.

Keywords: prostate gland, nephrolithiasis, environmental stress, morphometric analysis, histological changes, glandular acini, connective tissue stroma, oxidative stress.

Introduction

The prostate gland is an important accessory gland of the male reproductive system. Anatomically and histologically, it consists of numerous glandular structures surrounded by connective tissue and smooth muscle fibers. The glandular epithelium is responsible for producing and secreting components of prostatic fluid, which contribute to sperm viability and reproductive function.

The normal morphological condition of the prostate gland depends on several physiological factors, including endocrine regulation, blood circulation, metabolic balance, and the functional activity of the urinary system. Any disturbance in these regulatory mechanisms may lead to structural and functional changes in prostate tissue.

Nephrolithiasis is one of the most widespread disorders of the urinary system. It develops as a result of changes in urinary composition, mineral metabolism, and crystallization processes. The formation of kidney stones may be associated with calcium oxalate accumulation, disturbances in urinary pH, dehydration, and metabolic abnormalities. Environmental stress factors can further aggravate these pathological processes by increasing oxidative stress, promoting inflammatory reactions, and disrupting normal metabolic regulation.

Although nephrolithiasis primarily affects the kidneys, its systemic consequences may extend beyond the renal tissue. Changes in metabolic homeostasis, inflammatory

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mediators, and oxidative balance may potentially influence the structural organization of the prostate gland. Therefore, comparative morphological investigations are important for identifying possible relationships between renal pathology and changes in the male reproductive system.

Aim and Objectives of the Study

The main aim of this research is to investigate the morphological and morphometric characteristics of the prostate gland under normal physiological conditions and in experimental nephrolithiasis induced by environmental stress factors.

The specific objectives include:

- To examine the histological structure of the prostate gland in control and experimental animals.
- To determine the diameter and structural characteristics of glandular acini.
- To measure the height of glandular epithelial cells.
- To evaluate the thickness and organization of connective tissue stroma.
- To determine the relative proportions of glandular and stromal components.
- To identify possible inflammatory, degenerative, and adaptive tissue changes.
- To compare the obtained morphometric parameters between the experimental and control groups.

Materials and Methods

The proposed experimental investigation involves laboratory animals divided into two main groups: a control group and an experimental group.

Animals in the control group are maintained under standard laboratory conditions, while animals in the experimental group are subjected to an established experimental model of nephrolithiasis associated with environmental stress factors.

At the end of the experimental period, prostate gland tissue samples are collected following approved ethical procedures. The specimens are fixed in an appropriate fixative, processed using standard histological techniques, embedded in paraffin, and sectioned into thin slices.

Histological sections are stained with hematoxylin and eosin to evaluate the general tissue architecture. Microscopic examination is performed using a light microscope equipped with a digital imaging system.

The main morphometric parameters include the diameter of glandular acini, epithelial cell height, thickness of the connective tissue stroma, and the relative area occupied by glandular and stromal components. Special attention is also given to the condition of glandular lumina, epithelial arrangement, and the presence of inflammatory or degenerative alterations.

Quantitative measurements are analyzed statistically. The results are intended to be expressed as mean values and standard deviations (M±SD). Differences between the experimental and control groups can be evaluated using appropriate statistical tests, with $p<0.05$ considered statistically significant.

Results and Discussion

The comparative morphometric investigation is expected to provide important information regarding possible structural alterations in the prostate gland during nephrolithiasis associated with environmental stress.

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Under normal physiological conditions, the prostate gland is characterized by an organized arrangement of glandular acini, a well-developed epithelial lining, and a relatively balanced relationship between glandular and stromal components. The glandular epithelium generally consists of secretory cells supported by a basal cell layer and surrounded by connective tissue and smooth muscle elements.

In experimental nephrolithiasis, systemic metabolic disturbances and oxidative stress may potentially affect the structural organization of prostate tissue. Changes in the diameter of glandular acini, epithelial cell height, and stromal thickness may serve as indicators of tissue remodeling. Furthermore, inflammatory responses and disturbances in microcirculation may contribute to alterations in the glandular epithelium and surrounding connective tissue.

The morphometric assessment of these parameters is particularly important because visual histological examination alone may not provide sufficient information about the extent of structural changes. Quantitative analysis makes it possible to identify even relatively subtle differences between normal and pathological tissue conditions.

The relationship between renal dysfunction and prostate morphology deserves further investigation. In particular, the possible contribution of oxidative stress, inflammatory mediators, and metabolic imbalance to prostate tissue remodeling may provide new insights into the systemic consequences of nephrolithiasis.

Conclusion

The comparative morphometric analysis of the prostate gland under normal conditions and environmental stress-induced nephrolithiasis represents an important approach to understanding the systemic effects of urinary system pathology.

The evaluation of glandular acini, epithelial cell height, connective tissue stroma, and the relative distribution of tissue components may help identify potential morphological alterations associated with experimental nephrolithiasis.

The study may provide additional morphological evidence concerning the relationship between renal pathology and the structural organization of the male reproductive system. Further histological, morphometric, and biochemical investigations are necessary to establish the mechanisms underlying these changes and determine their functional significance.