



**ASSESSMENT OF MORPHOLOGICAL CHANGES IN THE ADRENAL CELLS IN
NONVIOLENT DEATH**

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Annotation. The adrenal glands play a crucial role in the regulation of stress responses and maintenance of homeostasis. In forensic medical practice, the evaluation of adrenal morphology is of particular importance in cases of nonviolent death, especially when external signs of injury are absent. The present study aims to assess morphological changes in the cells of the adrenal cortex and medulla in cases of nonviolent death and to determine their forensic significance. The material of the study included adrenal gland tissue samples obtained during medico-legal autopsies of individuals who died from nonviolent causes. Standard histological staining techniques and light microscopic examination were applied. The results revealed characteristic morphological changes, including dystrophic alterations, redistribution of lipid inclusions, vascular disturbances, and signs of functional exhaustion of the adrenal cortex, as well as stress-related changes in medullary cells during the terminal period. These findings indicate that morphological assessment of the adrenal glands may serve as an additional objective criterion in the forensic evaluation of nonviolent death when interpreted in conjunction with clinical and pathological data.

Key words: Adrenal gland; morphological changes; nonviolent death; forensic medicine; histological examination; stress response; terminal period; endocrine system.

**НОЗЎРАКИ ЎЛИМ ҲОЛАТЛАРИДА БУЙРАК УСТИ БЕЗИНИНГ МОРФОЛОГИК
ЎЗГАРИШЛАРИНИ БАҲОЛАШ.**

Аннотация. Буйрак усти безлари эндокрин тизимнинг муҳим аъзоларидан бири бўлиб, организмнинг мослашув ва стрессга жавоб реакцияларини таъминлайди. Суд-тиббиёт амалиётида нозўраки ўлим ҳолатларини таҳлил қилишда, айниқса ташқи шикастланиш белгилари аниқланмаган ҳолларда, буйрак усти безларидаги морфологик ўзгаришларни ўрганиш катта аҳамиятга эга. Ушбу тадқиқотнинг мақсади нозўраки ўлим ҳолатларида буйрак усти безининг кўрқувчи ва мия қисми хужайраларида кузатиладиган морфологик ўзгаришларни баҳолаш ҳамда уларнинг суд-тиббиёт аҳамиятини аниқлашдан иборат. Тадқиқот материали сифатида нозўраки сабаблар натижасида вафот этган шахсларнинг суд-тиббиёт вскрытиелари давомида олинган буйрак усти бези тўқималари ўрганилди. Стандарт гистологик бўйаш усуллари ва микроскопик таҳлил қўлланилди. Тадқиқот натижаларига кўра, буйрак усти бези кўрқувчи қисмида дистрофик ўзгаришлар, липид кўшимчаларининг қайта тақсимланиши, қон томир бузилишлари ва функционал ҳолдан тойиш белгилари аниқланди. Мия қисми хужайраларида эса терминал даврда юзага келадиган стресс реакциясини акс эттирувчи ўзгаришлар кузатилди. Хулоса қилиб айтганда, буйрак усти безларининг морфологик баҳоланиши нозўраки ўлим ҳолатларини



суд-тиббиёт жихатдан баҳолашда кўшимча объектив мезон сифатида хизмат қилиши мумкин.

Калит сўзлар: буйрак усти беши; морфологик ўзгаришлар; нозўраки ўлим; суд-тиббиёт; гистологик текширув; стресс реакцияси; терминал давр; эндокрин тизим.

ОЦЕНКА МОРФОЛОГИЧЕСКИХ ИЗМЕНЕНИЙ НАДПОЧЕЧНИКОВ ПРИ НЕНАСИЛЬСТВЕННОЙ СМЕРТИ.

Аннотация. Надпочечники являются ключевыми органами эндокринной системы, обеспечивающими регуляцию адаптационных и стресс-реакций организма. В судебно-медицинской практике исследование морфологических изменений надпочечников имеет важное значение при анализе случаев ненасильственной смерти, особенно при отсутствии выраженных внешних признаков травмы. Целью настоящей работы является оценка морфологических изменений клеток коркового и мозгового вещества надпочечников при ненасильственной смерти и определение их судебно-медицинской значимости. Материалом исследования послужили образцы ткани надпочечников, полученные при судебно-медицинских вскрытиях лиц, умерших от ненасильственных причин. Применялись стандартные гистологические методы окраски и микроскопического анализа. В результате выявлены характерные изменения в виде дистрофических процессов, перераспределения липидных включений, сосудистых расстройств и признаков функционального истощения коркового слоя надпочечников, а также изменения клеток мозгового вещества, отражающие стрессовую реакцию в терминальном периоде. Сделан вывод о том, что морфологическая оценка надпочечников может служить дополнительным объективным критерием при судебно-медицинской интерпретации ненасильственной смерти в комплексе с клиническими и патоморфологическими данными.

Ключевые слова: надпочечники; морфологические изменения; ненасильственная смерть; судебная медицина; гистологическое исследование; стресс-реакция; терминальный период; корковое и мозговое вещество надпочечников.

Introduction. Nonviolent death constitutes a significant proportion of cases encountered in forensic medical practice and often presents considerable diagnostic challenges, particularly when external signs of trauma are absent. In such situations, the forensic expert relies primarily on internal organ examination and histopathological analysis to reconstruct the terminal processes and determine the mechanism of death [1,2,4]. The adrenal glands play a central role in the regulation of physiological stress responses through the secretion of glucocorticoids, mineralocorticoids, and catecholamines. Due to their high functional activity and rich vascular supply, adrenal tissues are especially sensitive to hypoxia, circulatory disturbances, and metabolic imbalance occurring during the agonal and terminal periods [1,2,8,10]. Morphological alterations in adrenal cortical and medullary cells may therefore reflect the intensity and duration of stress preceding death [12,15,16]. Previous pathological and forensic studies have demonstrated that both acute and prolonged stress conditions can lead to characteristic changes in the adrenal cortex, particularly in the zona fasciculata, including lipid depletion, cellular dystrophy, and vascular congestion [9,13,14]. Changes in the adrenal medulla, such as chromaffin cell degeneration and vascular disturbances, are associated with excessive catecholamine release during terminal states [3,5,6]. Despite the absence of pathognomonic features, the assessment of adrenal gland morphology may provide valuable supplementary information in the forensic evaluation of nonviolent death. When interpreted in conjunction with



clinical history, autopsy findings, and histological changes in other organs, adrenal morphological changes can assist in estimating the agonal period and identifying stress-related mechanisms of death [2,5,6,16]. The aim of the present study is to assess morphological changes in the adrenal cells in cases of nonviolent death and to evaluate their forensic and diagnostic significance.

Objective. The objective of the present study is to perform a comprehensive morphological assessment of the adrenal cortex and medulla in cases of nonviolent death, focusing on histological changes associated with stress response, hypoxia, and terminal circulatory disturbances [2,6,7,16]. Particular attention is given to identifying dystrophic, degenerative, and vascular alterations in different adrenal zones, especially the zona fasciculata, which is known to be highly sensitive to acute and chronic stress conditions [11,16]. Another objective of this study is to analyze the relationship between adrenal morphological changes and the presumed duration and intensity of the agonal period, as reflected by lipid depletion, cellular exhaustion, and microcirculatory disorders within adrenal tissue [2,6,7,16]. The study also aims to evaluate whether these morphological features can be interpreted as indicators of systemic stress and endocrine imbalance preceding death. In addition, this research seeks to determine the forensic significance of adrenal gland morphology as a supplementary diagnostic criterion in the medico-legal evaluation of nonviolent death. The objective includes assessing the usefulness and limitations of adrenal histopathological findings when interpreted in combination with clinical history, autopsy results, and morphological changes in other organs, in order to enhance the objectivity and reliability of forensic conclusions [7,16].

Materials and Methods. The study material consisted of adrenal gland tissue samples obtained during routine medico-legal autopsies of individuals who died from nonviolent causes. The causes of death included acute cardiovascular failure, sudden cardiac death, respiratory insufficiency, and metabolic disorders. Cases involving mechanical trauma, poisoning, thermal injury, violent asphyxia, or advanced putrefaction were excluded from the study to avoid confounding morphological changes [2,16]. All autopsies were performed in accordance with national medico-legal regulations and standard forensic protocols. Demographic data, medical history, and available clinical information were reviewed for each case. Both adrenal glands were examined macroscopically, with attention paid to size, consistency, color, and the presence of hemorrhages or focal lesions. Representative tissue samples were taken from the cortical and medullary regions of each adrenal gland to ensure evaluation of all anatomical zones, including the zona glomerulosa, zona fasciculata, zona reticularis, and medulla [2,6,7,16]. **Histological Processing.** Tissue samples were fixed in 10% neutral buffered formalin for 24–48 hours, processed using standard paraffin-embedding techniques, and sectioned at a thickness of 4–5 μm . Histological sections were stained with hematoxylin and eosin (H&E) for general morphological assessment. Additional staining methods, including Periodic acid–Schiff (PAS) reaction and lipid-specific stains when applicable, were used to evaluate intracellular changes and vascular alterations [7,16]. (Kumar et al., 2020). **Microscopic Evaluation.** Histological examination was performed using light microscopy. The following parameters were assessed: cellular morphology, degree of cytoplasmic vacuolization, lipid distribution, nuclear changes, vascular congestion, hemorrhage, and interstitial edema. Morphological changes were evaluated semi-quantitatively and documented through photomicrography. **Statistical and Analytical Approach.** The findings were analyzed descriptively, with morphological changes correlated with the presumed mechanism of death and available clinical data. Due to the qualitative nature of the



histopathological assessment, statistical analysis was limited to frequency distribution of observed changes [2,8,9].

Conclusion. The morphological assessment of the adrenal glands in cases of nonviolent death reveals a spectrum of stress-related and degenerative changes involving both the cortical and medullary components. The most prominent alterations are observed in the adrenal cortex, particularly in the zona fasciculata, and include lipid depletion, cytoplasmic dystrophy, vascular congestion, and signs of functional exhaustion. Changes in the adrenal medulla reflect catecholamine-mediated responses to hypoxia and circulatory disturbances during the terminal period. Although these morphological findings are not pathognomonic for a specific cause of death, they provide valuable supplementary information regarding the intensity and duration of the agonal process. When interpreted in conjunction with clinical history, autopsy findings, and histopathological changes in other organs, adrenal gland morphology contributes to a more objective and comprehensive medico-legal evaluation of nonviolent death. Further research integrating immunohistochemical and molecular approaches is warranted to enhance the diagnostic and forensic significance of adrenal gland examination and to establish standardized criteria for the interpretation of stress-related morphological changes in forensic practice.

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