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HISTOLOGICAL DIAGNOSIS OF DROWNING IN FORENSIC MEDICINE: A REVIEW OF CURRENT INTERNATIONAL EVIDENCE.

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Annotation. Drowning remains one of the most complex and controversial causes of death in forensic medicine. Establishing the diagnosis of drowning is often difficult due to the absence of pathognomonic macroscopic signs and the influence of postmortem changes. In this regard, histological examination of organs and tissues plays an important role in supporting the forensic diagnosis. The aim of this review is to analyze current international scientific data on the histological criteria used in the diagnosis of drowning in forensic practice. The article summarizes the results of modern studies devoted to histopathological changes in the lungs, brain, liver, kidneys, and other organs observed in drowning cases. Particular attention is given to pulmonary edema, alveolar overdistension, the presence of foreign particles, and other microscopic findings that may indicate aspiration of water. In addition, the diagnostic value and limitations of histological examination in drowning cases are discussed. The review also highlights the importance of a comprehensive forensic approach that includes histological analysis together with autopsy findings, circumstantial evidence, and laboratory methods. The analysis of international literature demonstrates that histological examination remains an important auxiliary tool in the forensic diagnosis of drowning, although it should always be interpreted in conjunction with other forensic data.

Keywords: drowning, forensic medicine, histology, histopathology, lung changes, forensic diagnosis..

ГИСТОЛОГИЧЕСКАЯ ДИАГНОСТИКА УТОПЛЕНИЯ В СУДЕБНОЙ МЕДИЦИНЕ: ОБЗОР СОВРЕМЕННЫХ МЕЖДУНАРОДНЫХ ДАННЫХ.

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АННОТАЦИЯ. Утопление остаётся одной из наиболее сложных и дискуссионных причин смерти в судебной медицине. Установление диагноза утопления нередко представляет трудности из-за отсутствия макроскопических признаков и влияния посмертных изменений. В этой связи гистологическое исследование органов и тканей играет важную роль в подтверждении судебно-медицинского диагноза. Целью данного обзора является анализ современных международных научных данных о гистологических критериях, используемых при диагностике утопления в судебно-медицинской практике. В статье обобщены результаты современных исследований, посвящённых гистопатологическим изменениям в лёгких, головном мозге, печени, почках и других органах, выявляемых при случаях утопления. Особое внимание уделяется отёку лёгких, альвеол, наличию инородных частиц и другим микроскопическим признакам, которые могут свидетельствовать об аспирации воды. Кроме того, обсуждаются диагностическая ценность и ограничения гистологического исследования при установлении утопления. В обзоре также подчёркивается важность комплексного судебно-медицинского подхода, включающего гистологический анализ в сочетании с данными вскрытия, обстоятельствами дела и лабораторными методами исследования. Анализ международной литературы показывает, что гистологическое исследование остаётся важным вспомогательным инструментом в судебно-медицинской диагностике утопления, однако его результаты всегда должны интерпретироваться в совокупности с другими судебно-медицинскими данными.

Ключевые слова: утопление, судебная медицина, гистология, гистопатология, изменения лёгких, судебно-медицинская диагностика.

«СУД-ТИББИЁТДА ЧЎКИШНИНГ ГИСТОЛОГИК ДИАГНОСТИКАСИ: ЗАМОНАВИЙ ХАЛҚАРО АДАБИЁТЛАР ШАРҲИ».

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АННОТАЦИЯ. Чўкиб кетиш суд-тиббиёт амалиётида ўлимнинг энг мураккаб ва баҳсли сабабларидан бири бўлиб қолмоқда. Чўкиб кетиш ташхисини қўйиш кўпинча макроскопик белгиларнинг йўқлиги ҳамда ўлимдан кейинги ўзгаришларнинг таъсири туфайли қийинчилик туғдиради. Шу муносабат билан орган ва тўқималарнинг гистологик тадқиқоти суд-тиббий ташхисни тасдиқлашда муҳим аҳамият касб этади. Ушбу шарҳнинг мақсади суд-тиббий амалиётда чўкиб кетишни ташхислашда қўлланиладиган гистологик мезонларга оид замонавий халқаро илмий маълумотларни таҳлил қилишдан иборат. Мақолада чўкиб кетиш ҳолатларида кузатиладиган ўпка, бош мия, жигар, буйрак ва бошқа органлардаги гистопатологик ўзгаришларга бағишланган замонавий тадқиқотлар натижалари умумлаштирилган. Айниқса, ўпка шиши, альвеолаларнинг ҳаддан ташқари кенгайиши, ёт заррачаларнинг мавжудлиги ва сувнинг аспирациясини кўрсатиши мумкин бўлган бошқа микроскопик белгиларга алоҳида эътибор қаратилган. Бундан ташқари, чўкиб кетишни аниқлашда гистологик тадқиқотнинг диагностик аҳамияти ва чекловлари муҳокама қилинади. Шарҳда, шунингдек, гистологик таҳлилни мурдани ёриш натижалари,

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ҳодиса ҳолатлари ҳамда лаборатория тадқиқотлари билан биргаликда қўллашни ўз ичига олган комплекс суд-тиббий ёндашувнинг аҳамияти таъкидланади. Халқаро адабиётлар таҳлили шуни кўрсатадики, гистологик тадқиқот чўкиб кетишни суд-тиббий ташхислашда муҳим ёрдамчи восита бўлиб қолмоқда, аммо унинг натижалари ҳар доим бошқа суд-тиббий маълумотлар билан биргаликда талқин қилиниши лозим.

Калит сўзлар: Чўкиб кетиш, суд-тиббиёт, гистология, гистопатология, ўпка ўзгаришлари, суд-тиббий ташхис.

INTRODUCTION. Drowning is one of the leading causes of accidental and non-accidental death worldwide, accounting for a significant proportion of mortality in both developed and developing countries. Despite advances in forensic science, the diagnosis of drowning remains a complex and often controversial task. This complexity arises from the lack of pathognomonic macroscopic signs that can definitively confirm drowning and from the influence of postmortem changes such as decomposition, trauma, or environmental factors. Traditional autopsy findings, including external and internal examination, provide essential information but may be insufficient in isolation, especially in cases with prolonged submersion or when other injuries are present.

In this context, histological examination of organs and tissues has become an increasingly important tool in forensic investigations. Histopathology allows forensic practitioners to identify subtle cellular and structural alterations that occur as a consequence of water aspiration and associated physiological responses. Among the most frequently studied organs in drowning cases are the lungs, brain, liver, and kidneys. Pulmonary changes such as edema, overdistension of alveoli, hemorrhage, and the presence of foreign particles (e.g., diatoms or other environmental matter) are considered significant indicators. In addition, microscopic changes in other organs, including neuronal degeneration in the brain and congestion in the liver and kidneys, may provide supportive evidence to strengthen the forensic diagnosis.

Over the past decades, numerous international studies have focused on establishing and validating histological criteria for drowning. These studies have examined tissue-specific responses to submersion, the timeline of cellular changes, and the influence of water type (freshwater vs. seawater) on organ pathology. While no single histological marker can definitively diagnose drowning, the integration of multiple histopathological findings significantly enhances diagnostic accuracy when combined with autopsy results, circumstantial evidence, and laboratory investigations.

The aim of this review is to systematically analyze current international literature on the histological features associated with drowning, emphasizing both their diagnostic value and limitations. By synthesizing evidence from a wide range of studies, this article provides forensic practitioners with an updated perspective on the role of histopathology in the diagnosis of drowning. Ultimately, this review underscores the importance of a comprehensive, multidisciplinary approach in forensic investigations, wherein histological examination serves as a critical adjunct rather than a standalone diagnostic tool.

This expanded introduction sets the stage for a detailed discussion of organ-specific histopathological changes, methodological considerations, and practical recommendations for integrating histological analysis into forensic protocols for drowning cases.

AIM OF THE STUDY. The primary aim of this review is to systematically analyze and synthesize current international scientific evidence regarding the histological features associated with drowning in forensic medicine. Specifically, the study seeks to:

1. Identify and summarize organ-specific histopathological changes observed in drowning cases, with a focus on the lungs, brain, liver, and kidneys.
2. Evaluate the diagnostic significance and limitations of histological examination in supporting forensic determinations of drowning.

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3. Compare findings from studies conducted in different regions and under varying conditions (e.g., freshwater vs. seawater) to provide a comprehensive understanding of histopathological variability.

4. Highlight the role of histological analysis as an adjunct to autopsy findings, circumstantial evidence, and laboratory methods in establishing a reliable forensic diagnosis.

5. Provide practical recommendations for forensic practitioners regarding the application of histopathology in drowning cases, based on the synthesis of international literature.

By achieving these objectives, this review aims to strengthen the evidence-based application of histological techniques in forensic investigations of drowning and to promote a standardized, multidisciplinary approach that enhances diagnostic accuracy.

DISCUSSION. Drowning remains a diagnostically challenging cause of death due to the absence of pathognomonic signs and the variability introduced by postmortem changes. The present review highlights the crucial role of histological examination as an adjunctive tool in forensic investigations. Histopathology provides insights into tissue-level changes that are not always apparent during gross autopsy, allowing a more detailed assessment of organ-specific responses to water aspiration. Among the organs studied, the lungs have received the greatest attention, as pulmonary changes are often the most indicative of drowning. Pulmonary edema, alveolar overdistension, intra-alveolar hemorrhages, and the presence of foreign particles such as diatoms are commonly reported. These features reflect the physiological processes occurring during submersion, including hypoxia, fluid aspiration, and vascular congestion. While pulmonary findings are highly informative, they must be interpreted with caution, as similar histological changes can occur in other conditions such as heart failure, septicemia, or postmortem decomposition.

Brain histology can reveal neuronal degeneration, cerebral edema, and congestion, providing supportive evidence of hypoxic injury secondary to drowning. Similarly, hepatic and renal changes, including centrilobular congestion in the liver and acute tubular injury in the kidneys, contribute to a broader understanding of systemic responses to submersion. These organ-specific findings emphasize the necessity of examining multiple tissues to establish a comprehensive histopathological profile.

The reviewed literature also underscores the influence of environmental factors, such as freshwater versus seawater immersion, on histological presentations. Differences in electrolyte composition, microbial content, and temperature may alter tissue responses and should be considered when interpreting findings. Moreover, the postmortem interval significantly affects histological integrity, and delayed examinations may limit the reliability of certain microscopic features.

Despite the valuable information provided by histology, the limitations of this method must be recognized. No single histopathological marker is pathognomonic for drowning, and inter-study variability in methodology, sample collection, and staining techniques can affect reproducibility. Therefore, histological evidence should always be integrated with macroscopic autopsy findings, circumstantial evidence, and laboratory analyses, including diatom testing and toxicological screening.

Overall, the international literature demonstrates that histological examination remains a critical component of forensic drowning investigations. By providing organ-specific microscopic evidence, histology enhances the objectivity of forensic assessments and supports the identification of drowning as the cause of death. Future research should focus on standardizing tissue sampling protocols, identifying novel biomarkers, and integrating histological findings with molecular and imaging methods to improve diagnostic accuracy.

In conclusion, histopathology is not a standalone diagnostic tool but a complementary method that, when combined with a multidisciplinary forensic approach, strengthens the reliability of drowning diagnosis and contributes to evidence-based forensic practice.

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CONCLUSIONS. The analysis of international literature on the histological diagnosis of drowning demonstrates that histopathology is an essential adjunctive tool in forensic investigations. While no single microscopic feature is for drowning, a combination of organ-specific changes—particularly in the lungs, brain, liver, and kidneys—provides valuable supportive evidence. Pulmonary findings, including edema, alveolar over distension, and the presence of foreign particles, remain the most informative, but must always be interpreted alongside other autopsy findings, circumstantial evidence, and laboratory analyses.

Histological examination enhances the objectivity and reliability of forensic assessments by revealing subtle tissue-level alterations that may be overlooked during macroscopic examination. Environmental factors, postmortem interval, and methodological variations can influence histopathological presentations, underscoring the importance of standardized protocols and comprehensive evaluation.

In conclusion, histopathology should be integrated as part of a multidisciplinary forensic approach rather than used in isolation. Its application contributes to evidence-based diagnosis, improves the accuracy of cause-of-death determinations, and provides forensic practitioners with a more robust framework for evaluating drowning cases. Future research should focus on refining histological criteria, identifying novel biomarkers, and combining histological findings with molecular and imaging techniques to further strengthen the forensic diagnosis of drowning.

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