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RADIATION SIGNS OF LATENT RENAL PARENCHYMA ISCHEMIA IN THE ABSENCE OF LABORATORY CHANGES

Abstract

Latent renal parenchyma ischemia represents an early stage of renal vascular injury in which laboratory parameters remain within normal limits. At this stage, structural and hemodynamic alterations precede measurable declines in renal function. Modern radiation-based imaging methods, particularly computed tomography (CT), magnetic resonance imaging (MRI), and functional nuclear techniques, allow detection of subtle ischemic changes in renal parenchyma. This article summarizes the key radiation signs of latent renal ischemia detectable before laboratory abnormalities appear and highlights their diagnostic significance.

Keywords: latent renal ischemia; renal parenchyma; imaging biomarkers; computed tomography; magnetic resonance imaging; renal perfusion; diffusion-weighted MRI; subclinical renal dysfunction; ischemic nephropathy; early diagnosis.

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LABORATOR O‘ZGARISHLAR BO‘LMAGANDA YASHIRIN BUYRAK PARENXIMASI ISHEMIYASINING NURLI BELGILARI.

Abstrakt

Buyrak parenximasining yashirin ishemiyasi buyrak tomirlari shikastlanishining erta bosqichi bo‘lib, unda laboratoriya ko‘rsatkichlari normal chegaralarda qoladi. Bu bosqichda struktura va gemodinamik o‘zgarishlar buyrak funksiyasining o‘lchanadigan pasayishidan oldin sodir bo‘ladi. Zamonaviy radiatsion tasvirlash usullari, xususan, kompyuter tomografiyasi (KT), magnit-rezonans tomografiyasi (MRT) va funksional yadro usullari buyrak parenximasidagi nozik ishemik o‘zgarishlarni aniqlash imkonini beradi. Ushbu maqolada laboratoriya anomaliyalari paydo bo‘lishidan oldin aniqlanadigan yashirin buyrak ishemiyasining asosiy radiatsion belgilari umumlashtirilgan va ularning diagnostik ahamiyati yoritilgan.

Tayanch iboralar: yashirin buyrak ishemiyasi; buyrak parenximasi; tasviriy biomarkerlar; kompyuter tomografiyasi; magnit-rezonans tomografiya; buyrak perfuziyasi; diffuzion MRT; subklinik buyrak disfunksiyasi; ishemik nefropatiya; erta tashxis.

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РАДИАЦИОННЫЕ ПРИЗНАКИ ЛАТЕНТНОЙ ПОЧЕЧНОЙ ИШЕМИИ ПРИ ОТСУТСТВИИ ЛАБОРАТОРНЫХ ИЗМЕНЕНИЙ

Абстракт

Латентная ишемия почечной паренхимы представляет собой раннюю стадию повреждения почечных сосудов, при которой лабораторные параметры остаются в пределах нормы. На этой стадии структурные и гемодинамические изменения предшествуют значительному снижению функции почек. Современные методы лучевой визуализации, в частности компьютерная томография (КТ), магнитно-резонансная томография (МРТ) и функциональные ядерные методы, позволяют обнаруживать тонкие ишемические изменения в паренхиме почек. В данной статье обобщены основные лучевые признаки латентной почечной ишемии, обнаруживаемые до появления лабораторных аномалий, и подчеркнуто их диагностическое значение.

Ключевые слова: латентная почечная ишемия; почечная паренхима; визуализирующие биомаркеры; компьютерная томография; магнитно-резонансная томография; почечная перфузия; диффузионная МРТ; субклиническая почечная дисфункция; ишемическая нефропатия; ранняя диагностика.

Introduction

Renal ischemia is a progressive process that often remains clinically silent until significant parenchymal damage has occurred. Conventional laboratory markers, such as serum creatinine and estimated glomerular filtration rate, lack sensitivity in detecting early ischemic injury. As a result, diagnosis is frequently delayed, limiting opportunities for timely intervention.

Radiation-based imaging techniques provide direct or indirect assessment of renal perfusion, microvascular integrity, and parenchymal viability. Identification of early radiological markers of ischemia may allow recognition of high-risk patients before irreversible renal damage develops.

Materials and Methods

Radiological assessment of latent renal ischemia includes multiphasic CT, contrast-enhanced and functional MRI, and radionuclide imaging. Imaging protocols focus on evaluating renal cortical perfusion, corticomedullary differentiation, parenchymal density or signal characteristics, and perfusion asymmetry.

Table 1. Radiation signs of latent renal parenchyma ischemia

Imaging modality	Key sign	Pathophysiological correlate
CT	Reduced cortical attenuation	Decreased perfusion
CT (contrast)	Delayed enhancement	Impaired microcirculation
MRI (DWI)	Low ADC values	Cellular edema
MRI (perfusion)	Cortical hypoperfusion	Microvascular ischemia
Nuclear imaging	Functional asymmetry	Regional ischemia

CT analysis includes measurement of cortical attenuation values and assessment of delayed or heterogeneous contrast enhancement. MRI protocols incorporate diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and arterial spin labeling for non-contrast perfusion evaluation. Nuclear medicine techniques assess regional renal perfusion and functional asymmetry.

Results

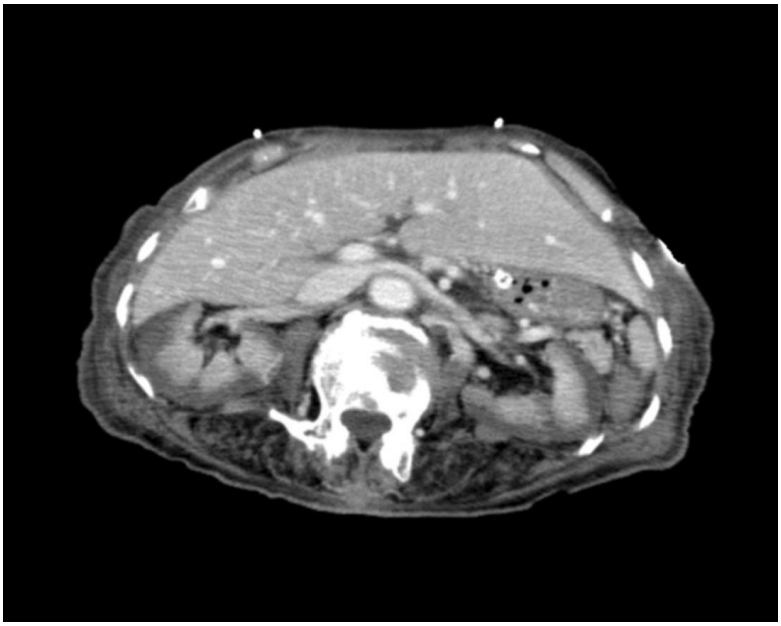
In patients without laboratory evidence of renal dysfunction, imaging frequently reveals subtle but reproducible ischemic changes. CT demonstrates reduced cortical attenuation and delayed contrast wash-in, particularly in segmental or subsegmental distributions. MRI findings include decreased ADC values in affected cortical regions, reflecting early cellular edema and microvascular compromise.

Perfusion-sensitive techniques reveal asymmetric cortical blood flow and reduced regional perfusion reserve. These changes are often focal or patchy, corresponding to areas of microvascular insufficiency rather than global renal failure.

Discussion

Radiation signs of latent renal ischemia reflect early microvascular pathology rather than advanced parenchymal loss. Reduced cortical perfusion, altered diffusion characteristics, and subtle enhancement abnormalities precede biochemical deterioration and represent an imaging biomarker of subclinical disease.

Figure 1. CT signs of renal cortical hypoperfusion



Early detection is clinically relevant, as latent ischemia is potentially reversible with timely correction of vascular risk factors or revascularization strategies. Imaging therefore plays a prognostic role, identifying patients at risk for progression to chronic ischemic nephropathy.

Conclusion

Radiation-based imaging techniques allow detection of latent renal parenchyma ischemia in the absence of laboratory changes. Subtle alterations in perfusion, enhancement, and diffusion parameters serve as early markers of renal microvascular injury. Incorporation of these imaging signs into clinical

algorithms may improve early diagnosis, risk stratification, and prevention of irreversible renal damage.

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