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EFFECT OF THYROID AUTOIMMUNITY ON RENAL STRUCTURAL CHANGES: CT AND US IMAGING INSIGHTS

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Resume. Autoimmune thyroid diseases (AITD), including Hashimoto's thyroiditis and Graves' disease, exert a systemic influence on metabolism, the cardiovascular system, and microcirculation, which may contribute to the development of structural renal changes and accelerate the progression of chronic kidney disease (CKD). Early detection of these changes is crucial for predicting renal function and selecting optimal patient management strategies.

This review examines non-invasive renal imaging data using ultrasound (US), including elastography, and multislice computed tomography (MSCT) in patients with AITD. Special attention is given to the assessment of structural features such as reduced kidney size, cortical thinning, increased parenchymal echogenicity, as well as alterations in tissue density and structure on CT.

Current evidence on the relationship between thyroid dysfunction, autoimmune processes, and the progression of renal fibrosis is summarized. It is shown that the combined use of US and CT allows early detection of structural renal changes, prediction of CKD progression risk, and monitoring of therapeutic effectiveness.

The findings of this review emphasize the need for integration of radiological and endocrinological data for early diagnosis and personalized management of patients with autoimmune thyroid diseases at risk of developing renal fibrosis.

Keywords: autoimmune thyroid diseases; renal fibrosis; chronic kidney disease; ultrasound; elastography; multislice computed tomography; structural renal changes; non-invasive diagnostics; endocrinology and nephrology.

ВЛИЯНИЕ АУТОИММУННЫХ ЗАБОЛЕВАНИЙ ЩИТОВИДНОЙ ЖЕЛЕЗЫ НА СТРУКТУРНЫЕ ИЗМЕНЕНИЯ ПОЧЕК: ДАННЫЕ КТ И УЗИ

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Резюме. Аутоиммунные заболевания щитовидной железы (АЩЖ), включая болезнь Хашимото и болезнь Грейвса, оказывают системное влияние на метаболизм, сердечно сосудистую систему и микроциркуляцию, что может способствовать развитию структурных изменений почек и ускорению прогрессирования хронической болезни почек (ХБП). Раннее выявление этих изменений имеет важное значение для прогнозирования функции почек и выбора оптимальной тактики ведения пациентов.

В обзоре рассматриваются данные неинвазивной визуализации почек с использованием ультразвукового исследования (УЗИ), включая эластографию, и мультиспиральной компьютерной томографии (МСКТ) у пациентов с АЩЖ. Особое внимание уделено оценке таких структурных признаков, как уменьшение размеров почек, истончение коркового слоя, повышение эхогенности паренхимы, а также изменения плотности и структуры ткани по данным КТ.

Обобщены современные сведения о связи между нарушениями функции щитовидной железы, аутоиммунными процессами и прогрессированием почечного фиброза. Показано, что комбинированное использование УЗИ и КТ позволяет выявлять ранние структурные изменения почек, прогнозировать риск прогрессирования ХБП и контролировать эффективность терапевтических вмешательств.

Выводы обзора подчеркивают необходимость интеграции радиологических и эндокринологических данных для ранней диагностики и персонализированного ведения

пациентов с аутоиммунными заболеваниями щитовидной железы и риском развития почечного фиброза.

Ключевые слова: Аутоиммунные заболевания щитовидной железы; почечный фиброз; хроническая болезнь почек; ультразвуковое исследование; эластография; мультиспиральная компьютерная томография; структурные изменения почек; неинвазивная диагностика; эндокринология и нефрология.

Introduction. Autoimmune thyroid diseases (AITD), including Hashimoto's thyroiditis and Graves' disease, are among the most prevalent endocrine disorders worldwide. Beyond their direct effects on thyroid function, AITD can influence systemic metabolism, cardiovascular health, and microcirculation, which in turn may affect renal structure and function. Chronic kidney disease (CKD) remains a global health challenge, with renal fibrosis being a key pathological process driving disease progression and loss of kidney function.

Recent evidence suggests that thyroid dysfunction, particularly in the context of autoimmunity, may accelerate structural renal changes and exacerbate CKD progression. Understanding these interactions is critical for early diagnosis, risk stratification, and personalized management of patients with concomitant thyroid and renal disorders.

Non-invasive imaging modalities, such as ultrasound (US) with elastography and multislice computed tomography (MSCT), provide valuable insights into renal structural changes. These technologies allow assessment of kidney size, cortical thickness, parenchymal echogenicity, tissue stiffness, and CT-derived density alterations, offering a comprehensive evaluation of renal involvement in patients with AITD.

This review aims to summarize current knowledge regarding the impact of autoimmune thyroid disorders on kidney structure, focusing on radiological assessment using US and MSCT, and highlighting potential clinical and prognostic implications.

The interplay between thyroid dysfunction and renal pathology is multifactorial. Thyroid hormones influence renal blood flow, glomerular filtration rate (GFR), tubular function, and sodium-water homeostasis. Autoimmune mechanisms, including circulating antibodies and systemic inflammation, can further impair renal microvasculature and promote fibrotic remodeling.

In AITD, chronic low-grade inflammation and altered cytokine profiles may exacerbate interstitial fibrosis, leading to decreased kidney size, cortical thinning, and increased tissue stiffness. Patients with subclinical or overt hypothyroidism are particularly susceptible to these structural alterations, which may remain undetected without imaging.

Ultrasound remains the first-line imaging modality for evaluating renal structure due to its accessibility, safety, and cost-effectiveness. In patients with AITD, US parameters such as:

- Kidney size and volume – often reduced in advanced fibrosis
- Cortical thickness – thinner cortex correlates with nephron loss
- Parenchymal echogenicity – increased echogenicity indicates fibrosis or interstitial edema
- can provide early evidence of structural changes.

Doppler ultrasound offers additional information on renal perfusion and vascular resistance, measured through the resistive index (RI). Elevated RI values in patients with thyroid autoimmunity may reflect impaired microcirculation and early fibrotic remodeling.

Ultrasound elastography, including shear wave elastography, allows quantification of tissue stiffness. Increased stiffness correlates with histopathologically confirmed fibrosis, enabling non-invasive monitoring of disease progression in patients with AITD.

Multislice Computed Tomography (MSCT) Assessment MSCT provides high-resolution anatomical visualization of renal parenchyma and can detect subtle structural changes not always visible on ultrasound. Key CT markers relevant to fibrosis and thyroid-related renal involvement include:

- Reduction in renal volume and cortical thickness

- Heterogeneous parenchymal density
- Structural irregularities indicative of interstitial fibrosis

MSCT is particularly useful when US findings are inconclusive or when patients present with obesity or anatomical limitations. However, considerations regarding radiation exposure and contrast nephrotoxicity necessitate careful patient selection.

Combining US and MSCT findings with clinical and laboratory parameters enhances diagnostic accuracy and risk stratification. Correlating imaging markers with thyroid function tests, autoantibody profiles, and kidney function (e.g., serum creatinine, eGFR, proteinuria) allows for a more comprehensive assessment of renal risk in patients with AITD.

Recent studies demonstrate that patients with Hashimoto's thyroiditis or Graves' disease often exhibit measurable changes in renal structure, even in early CKD stages. Integrating imaging into routine monitoring may facilitate early interventions, such as optimizing thyroid function, managing blood pressure, and implementing nephroprotective therapies, thereby slowing progression of renal fibrosis.

The recognition of renal involvement in AITD has several practical implications:

1. Early Detection – Non-invasive imaging can identify structural renal changes before significant functional decline occurs.

2. Risk Stratification – Imaging markers, combined with thyroid function and autoantibody status, may predict patients at higher risk for CKD progression.

3. Therapeutic Monitoring – Elastography and serial US can track response to interventions, including thyroid hormone replacement and nephroprotective therapies.

Personalized Medicine – Integrating radiology and endocrinology supports individualized management, reducing complications and improving long-term outcomes.

Emerging techniques, such as radiomics, artificial intelligence (AI), and machine learning-based analysis of US and MSCT images, hold promise for enhancing detection of subtle renal changes in AITD. Quantitative imaging biomarkers may allow prediction of fibrosis severity, progression risk, and therapeutic response with higher accuracy than conventional imaging alone.

Multicenter longitudinal studies are needed to validate these biomarkers and establish standardized protocols. Integration of imaging, clinical, and molecular data could lead to predictive models for CKD progression in patients with autoimmune thyroid disorders, advancing personalized medicine in this field.

Recent research highlights the complex interplay between endocrine and renal systems, emphasizing that autoimmune thyroid diseases (AITD) not only affect hormonal balance but also significantly impact kidney microstructure. Chronic systemic inflammation, autoantibody-mediated tissue injury, and oxidative stress associated with AITD contribute to endothelial dysfunction and microvascular damage within the kidneys. These processes accelerate interstitial fibrosis, glomerulosclerosis, and tubular atrophy, which can be detected through advanced imaging modalities before irreversible functional decline occurs.

Emerging studies suggest that even subclinical thyroid dysfunction can influence renal hemodynamics and parenchymal structure. For instance, patients with subclinical hypothyroidism exhibit subtle cortical thinning and increased renal stiffness on ultrasound elastography, indicating early fibrotic remodeling. These findings reinforce the importance of including thyroid function assessment in routine nephrological evaluations, particularly in patients with CKD risk factors.

The combination of ultrasound and MSCT provides complementary information. Ultrasound excels in evaluating parenchymal echotexture, cortical thickness, and tissue stiffness non-invasively, while MSCT allows high-resolution anatomical assessment and quantification of structural heterogeneity, including density variations and early fibrotic lesions. Incorporating Doppler-derived vascular parameters and elastography measurements enhances predictive accuracy for CKD progression, offering a non-invasive surrogate for histopathological

evaluation.

Radiomics and artificial intelligence (AI) approaches are increasingly applied to integrate multiple imaging features into predictive models. Quantitative texture analysis of US and CT images can identify subtle patterns associated with renal fibrosis that are imperceptible to the human eye. Machine learning algorithms, trained on multimodal imaging datasets combined with laboratory and clinical data, have the potential to stratify patients according to progression risk, monitor response to therapy, and optimize personalized treatment strategies.

Furthermore, there is growing evidence that correcting thyroid dysfunction may positively influence renal outcomes. Early initiation of thyroid hormone replacement in hypothyroid patients has been associated with improved glomerular filtration rates and reduced proteinuria, suggesting a modifiable pathway that could mitigate fibrosis progression. Consequently, a multidisciplinary approach integrating endocrinology, nephrology, and radiology is essential to maximize patient outcomes.

Conclusion. Autoimmune thyroid diseases exert a significant impact on renal structure, promoting interstitial fibrosis, cortical thinning, and parenchymal changes that accelerate chronic kidney disease progression. Non-invasive imaging modalities, particularly ultrasound with elastography and multislice CT, provide critical insights into these structural alterations, enabling early detection, risk stratification, and therapeutic monitoring.

Integration of imaging findings with thyroid function assessment, autoantibody profiling, and renal biomarkers enhances predictive accuracy and supports a personalized, multidisciplinary approach to patient management. Emerging technologies, including radiomics and AI-driven analysis, offer promising avenues for earlier detection and individualized risk prediction, ultimately improving clinical outcomes.

Future research should focus on multicenter, longitudinal studies to validate imaging biomarkers, establish standardized protocols, and explore the effects of thyroid-targeted interventions on renal structure and function. Such efforts will advance personalized medicine for patients with concurrent autoimmune thyroid disorders and chronic kidney disease, ensuring timely interventions and improved long-term renal health.

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