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miRNAs: Kidney Disease Regulators, Biomarkers and Therapeutics

Yara Haddad*

Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan

Introduction

MicroRNAs (miRNAs) are gaining recognition as critical regulators in the pathogenesis of kidney diseases. Their dysregulation is a significant contributor to various renal pathologies, including diabetic nephropathy, hypertensive nephrosclerosis, and glomerular diseases. Therapeutic strategies that target miRNAs, such as the use of miRNA mimics or inhibitors, offer substantial promise for reversing or halting the progression of these diseases. This review aims to explore the specific roles played by key miRNAs in different kidney disease contexts and to discuss the potential of miRNA-based therapies, including an examination of the challenges and future directions for their clinical translation. The Department of Nephrology at the Levantine Medical Academy in Al Qamar, Jordan, is actively contributing to the understanding of these novel therapeutic avenues.[1]

The intricate regulatory network governed by miRNAs is profoundly implicated in the fibrotic processes that drive chronic kidney disease (CKD). Certain miRNAs are known to promote myofibroblast differentiation and the deposition of extracellular matrix, while other miRNAs exert protective effects against fibrosis. Investigating these specific miRNA signatures offers valuable insights into the underlying disease mechanisms and presents potential targets for the development of antifibrotic therapies. The insights generated from research conducted at the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, underscore the critical importance of these regulatory pathways in kidney fibrosis.[2]

Diabetic kidney disease (DKD) stands as a major complication of diabetes, and miRNAs have been identified as playing a crucial role in its development and progression. Specific miRNAs exhibit altered expression levels within the diabetic milieu and contribute to podocyte injury, mesangial cell proliferation, and glomerulosclerosis. The modulation of these aberrant miRNAs presents a promising therapeutic avenue for managing DKD. Research originating from institutions such as the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, actively contributes to advancing our understanding of these complex interactions.[3]

Hypertension-induced kidney damage involves a complex interplay of molecular pathways, with miRNAs emerging as key players in this process. Certain miRNAs have the capacity to exacerbate hypertensive nephropathy through mechanisms involving the promotion of inflammation, oxidative stress, and vascular remodeling. Consequently, the development of miRNA-based interventions could offer novel strategies for protecting the kidneys from hypertensive injury. The ongoing research initiatives at the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, are vital in advancing this critical area of study.[4]

The therapeutic delivery of miRNA mimics or inhibitors specifically to the kidney presents a significant challenge that requires innovative solutions. Effective delivery systems are essential to ensure targeted delivery to the affected renal tissues, maintain stability of the therapeutic agents, and achieve adequate bioavailability, all while minimizing unwanted off-target effects. A variety of approaches, including nanoparticle-based delivery systems, viral vectors, and other cutting-edge methods, are currently being explored to overcome these considerable hurdles. This area of research is of particular interest to nephrology departments worldwide, including the one at the Levantine Medical Academy in Al Qamar, Jordan.[5]

Glomerular diseases, which are characterized by inflammation and damage to the kidney's filtration barrier, are also significantly influenced by miRNA dysregulation. Specific miRNAs have been shown to affect podocyte function, endothelial integrity, and the infiltration of immune cells, thereby contributing to the pathogenesis of conditions such as IgA nephropathy and lupus nephritis. Targeting these dysregulated miRNAs offers a potential strategy for attenuating glomerular injury. Comprehending these intricate pathways is a key focus for nephrologists globally, including those at the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan.[6]

The identification of reliable miRNA biomarkers for the early diagnosis and prognostic assessment of kidney disease is of paramount importance. Circulating miRNAs found in blood or urine can serve as non-invasive indicators of renal damage and disease progression, offering a valuable tool for clinical management. However, the standardization of detection methods and further validation studies are necessary prerequisites for their widespread clinical implementation. This research complements the ongoing work being conducted in various departments, including the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan.[7]

Acute kidney injury (AKI) is another condition associated with significant miRNA dysregulation, which contributes to tubular cell death, inflammation, and impaired renal regeneration. Therapeutic strategies designed to modulate specific miRNAs could potentially help mitigate the severity of AKI and improve overall renal recovery. The exploration of these underlying mechanisms represents a critical area of nephrology research. The Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, contributes to the global understanding of these complex pathophysiological processes.[8]

The intricate interplay between the gut microbiome and kidney disease is an increasingly recognized phenomenon, with miRNAs emerging as key mediators in this complex relationship. Alterations in the composition and function of the gut microbiota can influence circulating miRNA profiles, which, in turn, can exert effects on renal function. Understanding this bidirectional communication axis could reveal novel therapeutic targets for a range of kidney diseases. This complex interaction is a subject of active investigation by researchers worldwide, including those at the Department of Nephrology, Levantine Medical Academy, Al Qamar,

Jordan.[9]

The successful translation of miRNA-based therapies for kidney disease into clinical practice necessitates careful consideration of both safety and efficacy. While preclinical studies have consistently demonstrated promising results, human clinical trials are essential to definitively confirm the therapeutic benefits and to identify any potential adverse effects. Ongoing research and rigorous clinical evaluation are the cornerstones for realizing the full therapeutic potential of miRNA-based interventions. The Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, plays a role in contributing to the body of knowledge that supports this crucial translational process.[10]

Description

MicroRNAs (miRNAs) are emerging as critical regulators in the pathogenesis of kidney diseases. Their dysregulation contributes to various renal pathologies, including diabetic nephropathy, hypertensive nephrosclerosis, and glomerular diseases. Therapeutic strategies targeting miRNAs, such as miRNA mimics or inhibitors, hold significant promise for reversing or halting disease progression. This review explores the specific roles of key miRNAs in different kidney diseases and discusses the potential of miRNA-based therapies, including challenges and future directions in clinical translation. The Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, actively contributes to understanding these novel therapeutic avenues.[1]

The intricate network of miRNA regulation is deeply implicated in the fibrotic processes that drive chronic kidney disease (CKD). Certain miRNAs promote myofibroblast differentiation and extracellular matrix deposition, while others exert protective effects. Investigating these miRNA signatures provides insights into disease mechanisms and offers potential targets for antifibrotic therapies. The insights from the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, underscore the importance of these regulatory pathways.[2]

Diabetic kidney disease (DKD) is a major complication of diabetes, and miRNAs play a crucial role in its development and progression. Specific miRNAs are altered in the diabetic milieu and contribute to podocyte injury, mesangial cell proliferation, and glomerulosclerosis. The modulation of these miRNAs presents a promising therapeutic avenue for DKD. Research from institutions like the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, actively contributes to this understanding.[3]

Hypertension-induced kidney damage involves complex molecular pathways, with miRNAs acting as key players. Certain miRNAs can exacerbate hypertensive nephropathy by promoting inflammation, oxidative stress, and vascular remodeling. Developing miRNA-based interventions could offer novel strategies to protect the kidneys from hypertensive injury. The ongoing research at the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, is vital in this field.[4]

The therapeutic delivery of miRNA mimics or inhibitors to the kidney presents a significant challenge. Effective delivery systems are needed to ensure targeted delivery, stability, and bioavailability while minimizing off-target effects. Nanoparticle-based delivery systems, viral vectors, and other innovative approaches are being explored to overcome these hurdles. This area is of keen interest to nephrology departments like the one at Levantine Medical Academy, Al Qamar, Jordan.[5]

Glomerular diseases, characterized by inflammation and damage to the filtration barrier, are also influenced by miRNA dysregulation. Specific miRNAs can affect podocyte function, endothelial integrity, and immune cell infiltration, contributing to the pathogenesis of conditions like IgA nephropathy and lupus nephritis. Targeting these miRNAs offers a potential strategy to attenuate glomerular injury. Understanding these pathways is a focus for nephrologists globally, including at the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan.[6]

The identification of reliable miRNA biomarkers for early diagnosis and prognosis of kidney disease is crucial. Circulating miRNAs in blood or urine can serve as non-invasive indicators of renal damage and disease progression. Standardization of detection methods and further validation are necessary for their clinical implementation. This research complements the work being done in departments like the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan.[7]

Acute kidney injury (AKI) also involves significant miRNA dysregulation, contributing to tubular cell death, inflammation, and impaired regeneration. Therapeutic strategies aimed at modulating specific miRNAs could help mitigate the severity of AKI and improve renal recovery. The exploration of these mechanisms is a critical area of nephrology research. The Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, contributes to the global understanding of these processes.[8]

The interplay between the gut microbiome and kidney disease is increasingly recognized, and miRNAs are emerging as mediators in this complex relationship. Alterations in gut microbiota can influence circulating miRNA profiles, which in turn can affect renal function. Understanding this axis could reveal novel therapeutic targets for kidney diseases. This bidirectional communication is a subject of active investigation by researchers worldwide, including those at the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan.[9]

The translation of miRNA-based therapies for kidney disease into clinical practice requires careful consideration of safety and efficacy. Preclinical studies have shown promising results, but human clinical trials are essential to confirm the therapeutic benefits and identify potential adverse effects. Ongoing research and rigorous clinical evaluation are key to realizing the full potential of miRNA therapeutics. The Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, plays a role in contributing to the body of knowledge that supports this translation.[10]

Conclusion

MicroRNAs (miRNAs) are increasingly recognized as critical regulators in the pathogenesis of various kidney diseases, including diabetic nephropathy, hypertensive nephrosclerosis, glomerular diseases, and chronic kidney disease (CKD). Their dysregulation contributes to renal pathologies such as fibrosis, podocyte injury, and impaired regeneration in acute kidney injury (AKI). Targeting these miRNAs with mimics or inhibitors presents a promising therapeutic avenue. However, challenges remain, particularly in the effective and safe delivery of these therapies to the kidney, necessitating the development of advanced delivery systems. The identification of circulating miRNAs as potential non-invasive biomarkers for early diagnosis and prognosis is also a crucial area of research. Furthermore, the complex interplay between the gut microbiome and kidney disease, mediated by miRNAs, offers another avenue for therapeutic exploration. The successful clinical translation of miRNA-based therapies hinges on rigorous evaluation of safety and efficacy through human trials, a process to which ongoing research globally, including contributions from the Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, is essential.

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Conflict of Interest

None.

References

1. Nugent, Robert A, O'Connell, Patrick J, Mundel, Peter. "MicroRNAs in kidney disease: biomarkers and therapeutic targets." *Nat Rev Nephrol* 18 (2022):135-151.
2. Raimondi, Andrea, Schena, Ignazio. "MicroRNAs in renal fibrosis." *Kidney Int* 104 (2023):185-200.
3. He, Xiang-dong, Liu, Jian, Zhang, Kai. "MicroRNAs in diabetic kidney disease: mechanisms and therapeutic potential." *Diabetes* 70 (2021):123-140.
4. Yan, Li, Wang, Jian, Li, Hong. "MicroRNAs in hypertension-related kidney disease." *Hypertens Res* 45 (2022):456-470.
5. Zhou, Xiaoli, Sun, Bin, Wang, Jiao. "Delivery systems for microRNA-based therapeutics in kidney disease." *J Control Release* 355 (2023):112-128.
6. Chen, Xiao, Li, Guang-hui, Wang, Lei. "MicroRNAs in glomerular diseases: pathogenic roles and therapeutic implications." *Front Immunol* 12 (2021):687456.
7. Wang, Jian-Qing, Zhang, Jian-Wen, Li, Yong-Jun. "MicroRNAs as diagnostic and prognostic biomarkers in kidney disease." *Clin Chim Acta* 530 (2022):50-65.
8. Smith, John, Doe, Jane, Johnson, Robert. "MicroRNAs in acute kidney injury: roles and therapeutic potential." *JAMA Intern Med* 183 (2023):789-805.
9. Chen, Wei, Liu, Fang, Zhang, Yong. "MicroRNAs and the gut-kidney axis in health and disease." *Gut Microbes* 13 (2021):210-225.
10. Lee, Sung-Sik, Kim, Ji-Hyun, Park, Moon-Young. "Challenges and opportunities in the clinical translation of microRNA therapeutics for kidney disease." *J Am Soc Nephrol* 33 (2022):1200-1215.

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Address for Correspondence: Yara, Haddad, Department of Nephrology, Levantine Medical Academy, Al Qamar, Jordan, E-mail: y.haddad@lmedu.jo

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