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Commentary

Exploring the MicroRNA Profiling and Liquid Biopsy in Biomolecular Therapy

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DESCRIPTION

MicroRNAs (miRNAs) are small non-coding RNA molecules that play a vital role in the regulation of gene expression. Their dysregulation has been implicated in various diseases, including cancer. In recent years, miRNA profiling has emerged as a promising tool for liquid biopsy in biomolecular therapy. Liquid biopsy proposals a non-invasive and dynamic approach to monitor disease progression and assess treatment responses. This comprehensive review explores the significance of microRNA profiling in liquid biopsy for biomolecular therapy, focusing on its applications, challenges, and future prospects. Biomolecular therapy has revolutionized the field of medicine by harnessing the power of molecular and cellular components to treat diseases at the genetic level. MicroRNAs, being key regulators of gene expression, have saved attention for their potential roles in biomolecular therapy. Liquid biopsy, a minimally invasive technique that involves the analysis of circulating biomarkers, compromises a unique avenue for monitoring diseases, particularly cancer, in real-time. This review aims to delve into the complex relationship between microRNA profiling and liquid biopsy in the context of biomolecular therapy.

MicroRNA biogenesis and function

MicroRNAs are short RNA molecules, typically 19-22 nucleotides in length that play a acute role in post-transcriptional gene regulation. They are transcribed from genomic DNA and processed through a series of steps to generate mature miRNAs. Once mature, miRNAs function by binding to the 3' Un Translated Region (UTR) of target messenger RNAs (mRNAs), leading to translational repression or mRNA degradation. The ability of miRNAs to regulate multiple target genes makes them potent players in various cellular processes.

Dysregulation of miRNAs in diseases

The dysregulation of miRNAs has been implicated in a wide range of diseases, including cancer, neurodegenerative disorders, cardiovascular diseases, and autoimmune conditions. In cancer, aberrant expression of miRNAs can contribute to tumorigenesis, metastasis, and drug resistance. The identification of specific miRNA signatures associated with different diseases has their for utilization as biomarkers for diagnostic and prognostic purposes.

Liquid biopsy as a revolutionary diagnostic tool

Traditional diagnostic methods often involve invasive procedures, such as tissue biopsy, which may not be feasible for continuous monitoring of disease progression or treatment response. Liquid biopsy, on the other hand, involves the analysis of biomolecules, such as circulating tumor DNA (ctDNA), Circulating Tumor Cells (CTCs), exosomes, and miRNAs, in bodily fluids like blood and urine. This non-invasive approach provides a real-time snapshot of the disease, making it an attractive option for personalized medicine.

Microrna profiling in liquid biopsy

MicroRNA profiling involves the identification and quantification of miRNAs in biological samples. In the context of liquid biopsy, the analysis of circulating miRNAs has gained significant attention due to their stability and presence in various body fluids. The expression patterns of circulating miRNAs can serve as valuable biomarkers for disease diagnosis, prognosis, and monitoring treatment responses.

Applications in cancer diagnosis and prognosis

One of the most explored areas of microRNA profiling in liquid biopsy is cancer diagnosis and prognosis. Specific miRNA signatures have been identified for various cancer types, allowing for early detection and classification. For example, elevated levels of miR-21, miR-155, and miR-210 have been associated with different cancers, serving as potential diagnostic markers. Additionally, the expression of certain miRNAs can provide insights into the prognosis of cancer patients, aiding in treatment decision-making. Assessing treatment responses is central for therapeutic strategies and improving patient outcomes. MicroRNA profiling in liquid biopsy allows for the dynamic monitoring of miRNA expression patterns during treatment. Changes in specific miRNA levels can serve as indicators of treatment efficacy or the emergence of drug resistance.

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This information can guide clinicians in making timely adjustments to the treatment plan.

While the potential of microRNA profiling in liquid biopsy is vast, several challenges need to be addressed to fully realize its clinical utility. One major challenge is the standardization of experimental protocols for miRNA isolation, detection, and quantification. Variability in sample processing and analysis methods can lead to inconsistencies and hinder the reproducibility of results. Another challenge is the identification of reliable reference genes for data normalization. Since miRNA levels can vary between individuals and under different physiological conditions, normalization is vital for accurate interpretation of expression data. However, selecting stable reference genes that are consistently expressed across diverse samples remains a complex task. Furthermore, the heterogeneity of miRNA expression in different cell types within the same sample poses a challenge in the interpretation of liquid biopsy data.

The development of techniques to distinguish the cellular origin of circulating miRNAs can enhance the specificity of biomarker identification.

Recent advancements in technology have facilitated the improvement of microRNA profiling methods. Next-Generation Sequencing (NGS) and quantitative Polymerase Chain Reaction (qPCR) techniques have enhanced the sensitivity and specificity of miRNA detection. Moreover, the integration of bioinformatics tools allows for the analysis of large datasets, aiding in the identification of novel miRNA biomarkers and their functional implications. The incorporation of exosomes-based miRNA profiling is another capable avenue.