Emerging biomarkers for atherosclerosis detection: Early diagnosis and personalized management.

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Introduction

Atherosclerosis is a chronic inflammatory disease characterized by the accumulation of lipids and immune cells in the arterial walls, leading to the formation of plaques. Timely detection of atherosclerosis is crucial for implementing preventive measures and personalized treatment strategies to reduce the risk of cardiovascular events. Traditional risk factors, such as age, gender, smoking, hypertension, and dyslipidemia, provide valuable insights, but they are limited in predicting individual susceptibility and disease progression. In recent years, significant progress has been made in identifying and validating emerging biomarkers that hold promise for improved detection and risk assessment of atherosclerosis. This article reviews some of the most promising emerging biomarkers and their potential implications in clinical practice [1].

MicroRNAs (miRNAs) are small non-coding RNA molecules that regulate gene expression. They have emerged as potential biomarkers for various diseases, including atherosclerosis. Certain miRNAs are differentially expressed in atherosclerotic lesions and can be detected in circulating blood, making them attractive candidates for non-invasive diagnostics. MiRNAs such as miR-21, miR-126, and miR-155 have shown associations with atherosclerosis development, plaque vulnerability, and cardiovascular events [2].

Circulating cell-free DNA (cfDNA) refers to fragments of DNA released into the bloodstream by apoptotic and necrotic cells. In atherosclerosis, cfDNA can carry specific genetic and epigenetic information related to plaque instability. Recent studies have shown that cfDNA levels, as well as the presence of specific DNA methylation patterns, can serve as potential biomarkers for assessing plaque vulnerability and predicting adverse cardiovascular events [3].

Lipidomics is the comprehensive analysis of lipid molecules in biological samples. Advancements in mass spectrometry techniques have enabled the identification and quantification of specific lipid species associated with atherosclerosis. Lipidomic profiling of plasma or serum samples has shown potential in distinguishing individuals with different stages of atherosclerosis and predicting future cardiovascular events beyond traditional lipid measurements [4].

Metabolomics involves the systematic analysis of small molecules involved in cellular metabolism. It provides a holistic view of metabolic alterations associated with disease states. Metabolomic profiling of blood samples has identified metabolites related to lipid metabolism, oxidative stress, and inflammation, offering insights into atherosclerosis pathogenesis and potential diagnostic markers.

Advancements in genetic and epigenetic research have uncovered numerous single nucleotide polymorphisms (SNPs) and epigenetic modifications associated with atherosclerosis. Genomic and epigenomic profiling can aid in identifying individuals at higher risk for developing atherosclerosis and help tailor preventive strategies. Genetic risk scores, which combine multiple SNPs, can provide a personalized approach to risk assessment [5].

Conclusion

Emerging biomarkers for atherosclerosis detection have the potential to enhance risk prediction, enable early diagnosis, and facilitate personalized management. These biomarkers offer insights into the underlying molecular mechanisms of atherosclerosis and can guide the development of targeted therapies. However, further validation and standardization of these biomarkers are necessary before their integration into routine clinical practice. Continued research efforts in this field hold promise for advancing the field of atherosclerosis diagnostics, improving patient outcomes, and reducing the burden of cardiovascular disease.

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