CLINICAL AND THERAPEUTIC ADVANCES IN DIABETES MELLITUS

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Abstract: Diabetes mellitus is one of the most prevalent endocrine disorders worldwide, characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The global burden of diabetes has increased dramatically in recent decades, driven by lifestyle changes, urbanization, and rising obesity rates. This article reviews the pathophysiology of diabetes, current diagnostic criteria, and modern approaches to treatment. The study emphasizes the importance of early diagnosis, lifestyle modification, and the use of novel therapeutic agents in reducing morbidity and mortality.

Keywords: diabetes mellitus, insulin resistance, type 1 diabetes, type 2 diabetes, SGLT2 inhibitors, GLP-1 receptor agonists

Introduction

Diabetes mellitus represents a major global health challenge, affecting more than 500 million individuals worldwide. The disease is associated with significant morbidity and mortality due to complications such as cardiovascular disease, kidney failure, neuropathy, and retinopathy. It is broadly classified into type 1 diabetes (autoimmune destruction of pancreatic beta cells leading to absolute insulin deficiency) and type 2 diabetes (a progressive condition characterized by insulin resistance and relative insulin deficiency). Gestational diabetes and monogenic diabetes represent additional subtypes with distinct clinical implications.

The rising incidence of type 2 diabetes is closely linked to obesity, physical inactivity, and poor dietary habits. In contrast, type 1 diabetes remains more prevalent in younger populations, with incidence increasing in many regions, possibly due to environmental triggers in genetically predisposed individuals. Advances in endocrinology and molecular medicine have expanded our understanding of the disease mechanisms, paving the way for new diagnostic and therapeutic approaches.

Methods

This article is based on a comprehensive review of literature published between 2016 and 2025, retrieved from PubMed, Scopus, and Web of Science. Keywords included "diabetes mellitus," "insulin resistance," "diabetes treatment," "GLP-1 agonists," and "SGLT2 inhibitors." Clinical practice guidelines from the American Diabetes Association (ADA) and the International Diabetes Federation (IDF) were analyzed to summarize current diagnostic and therapeutic standards.

Results

Pathophysiology

In type 1 diabetes, autoimmune-mediated beta-cell destruction leads to complete insulin deficiency. Genetic predisposition, viral infections, and immune dysregulation are key contributors. In type 2 diabetes, chronic overnutrition and sedentary lifestyles cause insulin resistance in peripheral tissues, followed by progressive beta-cell dysfunction. Increased lipotoxicity, glucotoxicity, and chronic inflammation play significant roles in disease progression.

Diagnosis

Diagnostic criteria are based on fasting plasma glucose ($\geq$126 mg/dL), 2-hour plasma glucose during oral glucose tolerance test ($\geq$200 mg/dL), HbA1c level ($\geq$6.5%), or random plasma glucose ($\geq$200 mg/dL) in symptomatic individuals. HbA1c testing is widely used due to its convenience and ability to reflect long-term glycemic control. Continuous glucose monitoring technologies are increasingly applied for early detection and precise disease monitoring.

Treatment

Lifestyle modifications, including diet optimization and regular physical activity, remain the cornerstone of diabetes management. Pharmacological therapy includes metformin as the first-line agent for type 2 diabetes, while insulin therapy is essential for type 1 diabetes and advanced type 2 diabetes. Novel therapies such as SGLT2 inhibitors and GLP-1 receptor agonists have demonstrated significant benefits, including cardiovascular and renal protection. Additionally, insulin pump therapy and closed-loop artificial pancreas systems have revolutionized the management of type 1 diabetes, improving quality of life for patients.

Complications

Chronic hyperglycemia leads to microvascular complications (retinopathy, nephropathy, neuropathy) and macrovascular complications (ischemic heart disease, stroke, peripheral arterial disease). Early screening, regular monitoring, and aggressive risk factor management are essential in reducing these complications.

Discussion

Diabetes mellitus remains a major public health issue due to its rising prevalence and long-term complications. Advances in diagnostic tools and therapies have improved patient outcomes, yet challenges persist in achieving widespread access, especially in low-resource settings. Personalized medicine approaches, including genetic profiling and biomarker identification, may further optimize treatment strategies in the future. Artificial intelligence and digital health

platforms are also expected to enhance disease monitoring and self-management.

Conclusion

Diabetes mellitus continues to represent one of the most significant global health burdens. Understanding its pathophysiology and implementing early diagnostic and therapeutic strategies are essential to reducing complications and mortality. Modern treatment options, including novel pharmacological agents and advanced insulin delivery systems, provide promising opportunities for improved patient care. Future efforts should focus on prevention, education, and equitable access to healthcare resources.

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