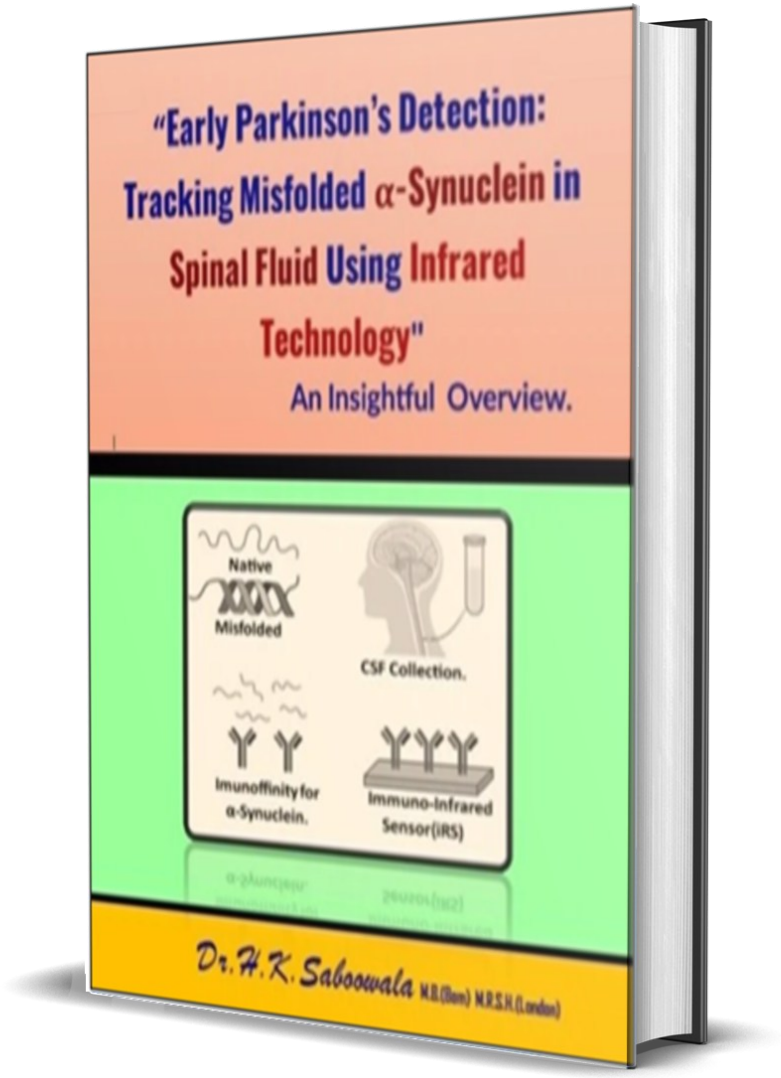
Early Detection of Parkinson's Disease Using Infrared Biomarker Technology: Advances in α-Synuclein Profiling



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This is a structured academic manuscript formatted for scholarly indexing, citation, and research visibility.

Abstract

Early detection of Parkinson's disease (PD) remains a major clinical challenge due to delayed onset of motor symptoms following significant neurodegeneration. Misfolded α-synuclein has emerged as a key biomarker, and infrared-based detection technologies such as immuno-infrared sensors (iRS) offer promising early diagnostic capability. This review examines infrared biomarker technology, diagnostic performance, and future clinical applications in early Parkinson's detection.

Keywords

Parkinson's disease, early detection, alpha-synuclein, infrared biomarkers, immuno-infrared sensor, neurodegeneration

Introduction

Parkinson's disease is a progressive neurodegenerative disorder characterized by degeneration of dopaminergic neurons. Clinical diagnosis often occurs after substantial neuronal loss, limiting early therapeutic intervention (1,2).

Advances in biomarker science have enabled detection of early molecular changes. Misfolded α-synuclein is a central pathological feature, and infrared spectroscopy is emerging as a promising detection tool.

Scholarly Identification

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α-Synuclein as a Core Biomarker

Misfolded α-synuclein aggregation is a hallmark of Parkinson's disease. Detection of structural abnormalities in cerebrospinal fluid provides insight into early neurodegeneration (3).

Infrared spectroscopy differentiates protein conformations through molecular vibration analysis, enabling early biomarker detection.

Infrared Biomarker Technology

Immuno-infrared sensors combine antibody specificity with infrared spectroscopy to detect conformational changes in α-synuclein.

Key advantages include:

- Detection prior to motor symptom onset
- Minimal sample requirement
- High sensitivity and specificity
- Non-radioactive methodology

Diagnostic Performance

Infrared biomarker analysis demonstrates detection accuracy of approximately 85–90% in pre-symptomatic individuals (3,4).

Ongoing research is exploring blood-based biomarker applications to improve accessibility.

Clinical Applications

Potential applications include:

- Early disease screening
- Risk stratification
- Monitoring disease progression

- Evaluating treatment response

Discussion

Despite promising results, limitations include the need for validation, standardization, and integration with existing diagnostic frameworks. Combining biomarkers with imaging and AI may enhance diagnostic accuracy (4,5).

Conclusion

Infrared biomarker technology represents a promising advancement in early Parkinson's detection. Early identification of α-synuclein misfolding may enable timely intervention and improved outcomes.

Conflict of Interest

The author declares no conflict of interest.

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Ethical Approval

Not applicable.

Data Availability

No new data were generated.

References

1. Kalia LV, Lang AE. Parkinson's disease. *Lancet*. 2015.
2. Postuma RB, Berg D. Prodromal Parkinson disease. *Nat Rev Neurol*. 2016.
3. Stockmann C, et al. Infrared spectroscopy in neurodegeneration. *Anal Chem*. 2016.
4. Esteva A, et al. Deep learning in healthcare. *Nat Med*. 2019.
5. Booij J, Knol RJJ. Imaging in Parkinson's disease. *Eur J Nucl Med*. 2007.

National Institute of Neurological Disorders and Stroke (NINDS):
https://www.ninds.nih.gov/health-information/disorders/parkinsons-disease

World Health Organization (WHO) – Neurological Disorders:
https://www.who.int/news-room/fact-sheets/detail/neurological-disorders

Read the full article and access the complete academic resource:

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