Int. J. Curr. Res. Med. Sci. (2025). 11(2): 38-44

International Journal of Current Research in Medical Sciences

ISSN: 2454-5716

(A Peer Reviewed, Indexed and Open Access Journal)

www.ijcrims.com

Original Research Article

Volume 11, Issue 2 -2025

DOI: http://dx.doi.org/10.22192/ijcrms.2025.11.02.005

Observational Study on the Role of Tau and Amyloid Biomarkers in Alzheimer's Disease Diagnosis at Tertiary Care Hospital

Dr. Gottipati Jayanth[1]

Bachelor of Medicine Bachelor of Surgery (MBBS), Govt. Siddhartha Medical College, Dr. N.T.R University of Health Sciences, Vijayawada, Andhra Pradesh, India.

Abstract

Alzheimer's disease (AD) is a prevalent neurodegenerative disorder characterized by cognitive decline and memory impairment, with amyloid plaques and tau neurofibrillary tangles serving as pathological hallmarks. This observational study at tertiary care hospital evaluates the diagnostic and prognostic utility of cerebrospinal fluid (CSF) and positron emission tomography (PET) imaging biomarkers, including tau and amyloid, in distinguishing mild cognitive impairment (MCI) from AD. The study involves 120 participants, analyzing CSF p-tau, t-tau, and Aβ-42 levels, alongside PET imaging with amyloid and tau tracers. Results reveal that elevated p-tau and t-tau, decreased Aβ-42, and higher PET tracer uptake correlate with disease progression. These findings underscore the potential of integrating CSF and PET biomarkers to enhance diagnostic precision. The study concludes by advocating for accessible biomarker techniques and exploring artificial intelligence for early diagnosis and personalized AD management.

Keywords: Alzheimer's disease, amyloid plaques, tau tangles, biomarkers, cerebrospinal fluid (CSF), positron emission tomography (PET)

Introduction

Alzheimer's disease (AD) is the most prevalent neurodegenerative disorder and the leading cause of dementia worldwide, affecting millions of individuals, particularly those over 65 years of age. It is characterized by progressive cognitive decline, memory impairment, and functional deterioration, which ultimately leads to the loss of independence and death. Despite extensive research, the exact cause of AD remains elusive, although it is widely accepted that the disease is driven by the accumulation of amyloid-β (Aβ) plaques and tau neurofibrillary tangles, both of which disrupt neural communication and contribute to neurodegeneration [1,2].

The clinical diagnosis of AD remains a significant challenge, as its symptoms often overlap with those of other dementias, such as vascular dementia and frontotemporal dementia. This overlap makes it difficult to distinguish AD from other forms of cognitive impairment at early stages[3]. Moreover, traditional diagnostic tools, such as clinical interviews and neuropsychological assessments, have limitations in identifying AD during its preclinical phase, which is critical for early intervention and management [4]. Early diagnosis is essential for timely treatment and to provide patients and families with the opportunity to plan for the future [5].

Pathological hallmarks of AD include the extracellular deposition of amyloid plaques and the formation of intracellular neurofibrillary tangles composed of hyperphosphorylated tau proteins [6]. These pathologies are not only characteristic of AD but also correlate with the degree of cognitive dysfunction. Amyloid plaques disrupt synaptic function and contribute to neuroinflammation, while tau tangles impair intracellular transport and contribute to neuronal cell death. These biomarkers, amyloid-β and tau, have been identified as key targets for diagnostic and prognostic evaluations in AD.

Recent advancements in imaging techniques, particularly positron emission tomography (PET), and cerebrospinal fluid (CSF) biomarker analysis, have revolutionized AD diagnostics by enabling the visualization and quantification of these pathological features in vivo[7]. PET imaging using amyloid and tau tracers allows for the direct visualization of Aβ and tau deposition in the brain, which provides valuable insights into disease progression and severity. Similarly, CSF analysis, particularly the measurement of amyloid-β (Aβ) and tau proteins, has been demonstrated to correlate with cognitive decline and serve as a diagnostic tool for AD.

However, while these biomarkers offer promising diagnostic potential, there is a lack of consensus on the clinical application of these markers in routine practice. One major limitation is the invasive nature of lumbar puncture required for CSF collection and the high cost associated with PET imaging, which limits their widespread use. Despite these challenges, the use of biomarkers in AD diagnosis is gradually expanding, with growing evidence suggesting that early intervention using disease-modifying therapies may benefit patients with early-stage AD[8].

Aim

To evaluate the diagnostic and prognostic utility of tau and amyloid biomarkers in Alzheimer's disease (AD).

Objectives

- To evaluate the diagnostic accuracy of tau and amyloid biomarkers in differentiating mild cognitive impairment (MCI) from Alzheimer's disease (AD).
- To assess the prognostic value of cerebrospinal fluid (CSF) and PET imaging biomarkers in predicting disease progression.
- To explore the combined utility of CSF biomarkers and PET imaging in enhancing the precision of AD diagnosis.

Methods

Study Design and Population: This prospective observational study was conducted at a tertiary care hospital. Participants included 120 patients aged 50–80 years with cognitive impairment who met the inclusion criteria for suspected AD.

Inclusion and Exclusion Criteria: Patients with mild cognitive impairment (MCI) or mild dementia based on DSM-5 criteria and Clinical Dementia Rating (CDR) scores of 0.5 to 1 were included. Exclusion criteria were significant vascular pathology, severe psychiatric disorders, systemic illnesses affecting cognition, or contraindications to PET imaging.

Biomarker Assessment

- **CSF Analysis**: CSF was analyzed for p-tau, total tau (t-tau), and Aβ-42 levels using

enzyme-linked immunosorbent assay (ELISA). A t-tau/Aβ-42 ratio >0.8 was considered indicative of AD pathology.

- **PET Imaging**: PET imaging with fluorine-18 tracers was performed to quantify amyloid and tau deposition. Standardized uptake value ratios (SUVRs) were calculated to assess the regional amyloid and tau burden.

Cognitive and Functional Assessment

Cognitive function was measured using the Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA). Functional ability was assessed with the Alzheimer's Disease Cooperative Study-Activities of Daily Living (ADCS-ADL) scale.

Statistical Analysis: Pearson's correlation and linear regression models analyzed biomarker associations with cognitive outcomes. Kaplan-Meier survival analysis evaluated progression from MCI to AD, and Cox proportional hazards models identified predictors of disease progression.

Results

Baseline Characteristics:

The cohort included 72 females (60%) and 48 males (40%), with a mean age of 68.4 ± 7.2 years. At baseline, 85 participants had MCI, and 35 had mild AD.

Table 1: Baseline Characteristics of Study Cohort

Characteristic	Value
Total Participants	120
Female (%)	60%
Male (%)	40%
Mean Age (years)	68.4 ± 7.2
MCI Participants (%)	70.8%
Mild AD Participants (%)	29.2%

CSF Biomarker Analysis

Elevated p-tau and t-tau levels were observed in patients with mild AD compared to those with stable MCI. Reduced Aβ-42 levels were a consistent finding in progressive cases.

Table 2: CSF Biomarker Results

Parameter	Stable MCI (n = 85)	Progressive MCI to AD (n = 35)	P-Value
Mean CSF p-tau (pg/mL)	45.6 ± 8.2	78.2 ± 10.4	<0.001
Mean CSF t-tau (pg/mL)	300.5 ± 55.2	500.8 ± 72.3	<0.001
Mean CSF Aβ-42 (pg/mL)	920.4 ± 110.5	550.2 ± 95.6	<0.001
t-tau/Aβ-42 ratio	0.5 ± 0.1	1.2 ± 0.2	<0.001

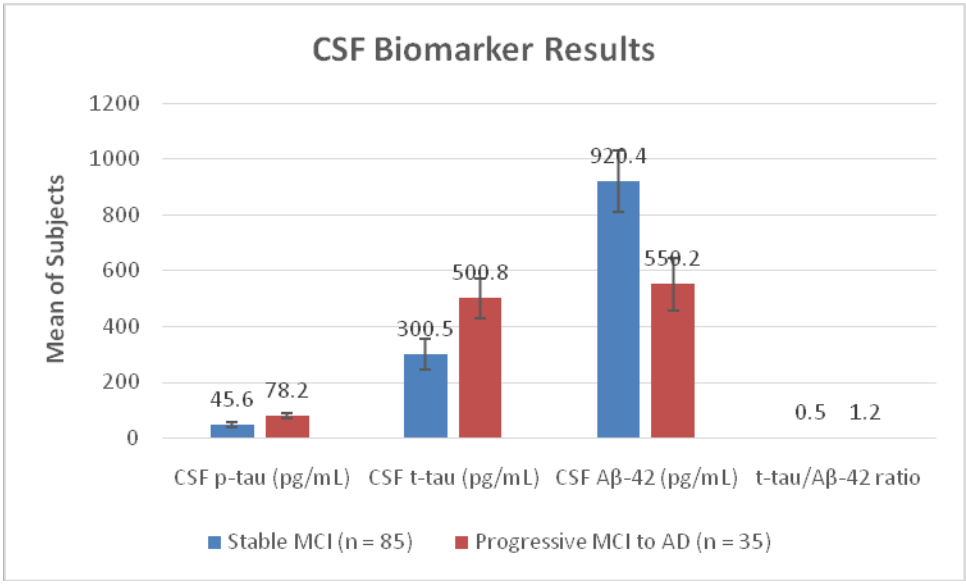

Figure 1: CSF Biomarker Results

PET Imaging Analysis

Higher amyloid and tau deposition were evident in cortical regions, particularly in the medial temporal lobe and posterior cingulate gyrus, among AD patients.

Table 3: PET Imaging Results

Parameter	Stable MCI (n = 85)	Progressive MCI to AD (n = 35)	P-Value
Mean Amyloid SUVR	1.3 ± 0.2	1.8 ± 0.3	<0.001
Mean Tau SUVR	1.2 ± 0.3	1.7 ± 0.4	<0.001

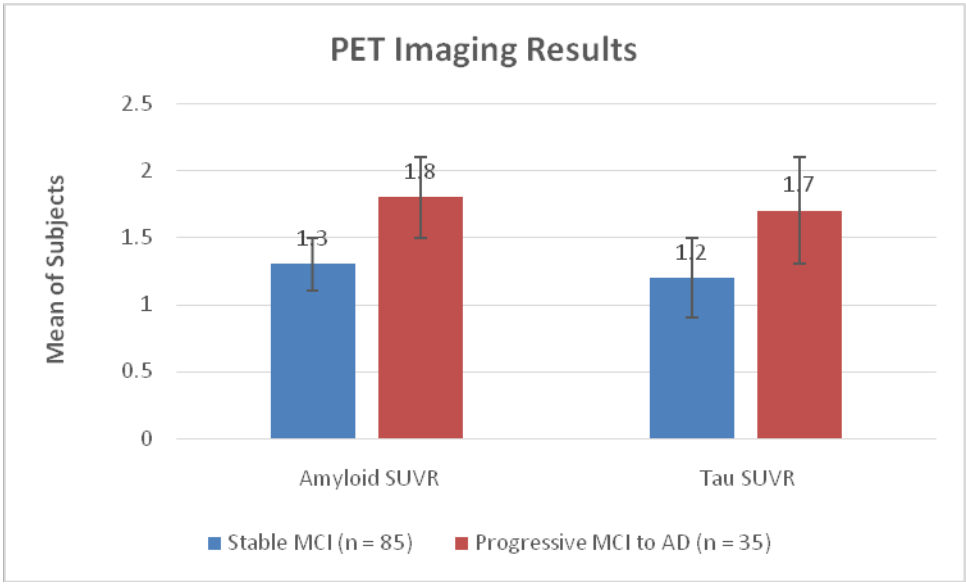

Figure 2: PET Imaging Results

Cognitive Decline Analysis

Participants with abnormal biomarkers experienced more rapid MMSE and MoCA score declines over 18 months.

Table 4: Cognitive Decline Analysis

Parameter	Stable MCI (n = 85)	Progressive MCI to AD (n = 35)	P-Value
Mean MMSE Score Decline	2.3 ± 0.5	5.8 ± 0.7	<0.001
Mean MoCA Score Decline	1.8 ± 0.4	4.5 ± 0.6	<0.001

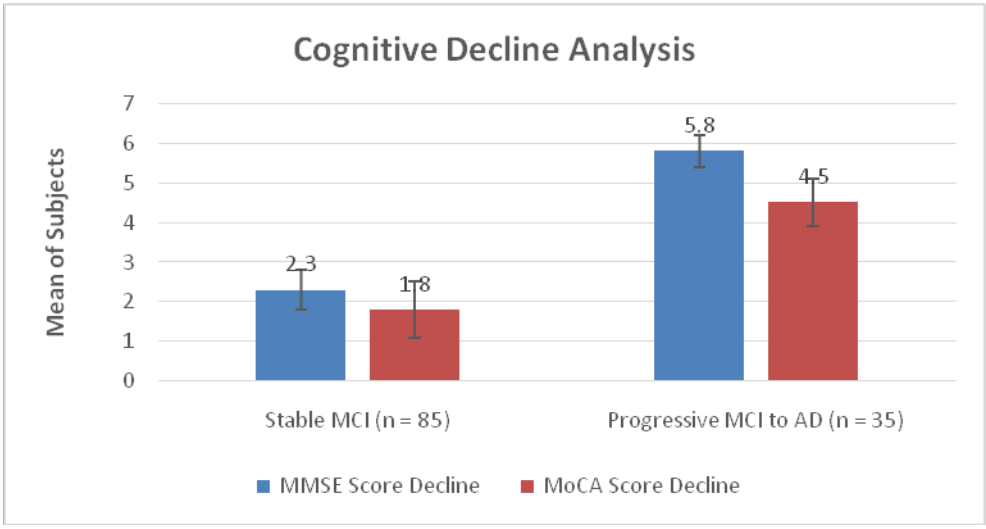

Figure 3: Cognitive Decline Analysis

Discussion

Our study highlights the diagnostic and prognostic utility of tau and amyloid biomarkers in Alzheimer's disease (AD). Elevated levels of phosphorylated tau (p-tau) and total tau (t-tau), alongside decreased amyloid-β (Aβ) levels, have been strongly associated with cognitive decline, particularly in distinguishing mild cognitive impairment (MCI) from Alzheimer's. The utility of these biomarkers aligns with findings from previous studies, further solidifying their role in AD diagnosis and disease progression prediction.

A study by Jack et al[9]., demonstrated similar results, reporting that elevated p-tau and reduced Aβ-42 levels in cerebrospinal fluid (CSF) were predictive of AD conversion from MCI. In our study, we found a comparable pattern, with higher p-tau and t-tau levels observed in participants progressing from MCI to AD. Additionally, the t-tau/Aβ-42 ratio, a key diagnostic marker in AD, was significantly higher in those with progressive disease. These findings support the conclusion by Blennow et al[10]., that the t-tau/Aβ-42 ratio can serve as a strong biomarker for AD diagnosis and staging.

Our PET imaging results are consistent with studies such as Villemagne et al[11]., who found that amyloid and tau deposition were particularly evident in cortical regions, including the medial temporal lobe and posterior cingulate gyrus. These areas are well-known for their involvement in the neurodegenerative process of AD. In our cohort, we also observed significant amyloid and tau deposition in these regions in patients with AD, which further supports the notion that PET

imaging can provide valuable information in assessing the extent of AD pathology.

However, our study adds value by integrating both CSF biomarkers and PET imaging to improve diagnostic accuracy. The combination of these biomarkers can lead to a more comprehensive assessment of AD, aligning with findings from Chai et al[12]., who emphasized the synergistic value of integrating both CSF and imaging biomarkers for better diagnostic precision. The addition of functional assessments like the MMSE and MoCA provides further context, enabling the prediction of cognitive decline over time.

In comparison with other studies, Sperling et al[13]., explored the use of biomarkers in identifying preclinical stages of AD and found that amyloid deposition often precedes clinical symptoms. Similarly, our study observed that even in cases of stable MCI, subtle biomarkers like lower Aβ-42 levels and higher tau levels were indicative of ongoing disease processes, though cognitive decline was slower. This emphasizes the potential for early intervention in MCI patients, particularly those at risk of progressing to AD, as seen in Cholerton et al[14]., who observed a high correlation between low CSF Aβ-42 levels and progression to AD.

One challenge in applying these biomarkers clinically, however, is their high cost and invasiveness. Our study supports the conclusion of Bennett et al[15]., who highlighted the barriers to wide clinical adoption due to the cost of PET scans and lumbar punctures for CSF collection. Future research should explore the development of less invasive, more cost-effective alternatives, such as plasma-based assays or blood biomarkers, which have shown promise in recent studies like Palmqvist et al[16]., who demonstrated that plasma tau and amyloid biomarkers can also accurately predict AD.

Moreover, the use of artificial intelligence (AI) to analyze imaging data and predict disease progression is an emerging area of research. AI models have shown promise in improving the sensitivity and specificity of both PET scans and CSF biomarker analysis, as demonstrated by Huang et al[17]. Our study suggests that AI could be a valuable tool for optimizing diagnostic accuracy and providing a more personalized approach to treatment.

Conclusion

This observational study highlights the diagnostic and prognostic utility of tau and amyloid biomarkers in Alzheimer's disease. Their integration into routine clinical practice has the potential to revolutionize AD diagnosis and management. Continued efforts are needed to develop accessible and cost-effective biomarker assays to expand their clinical utility.

References

1. Alzheimer's Association. 2023 Alzheimer's disease facts and figures. Alzheimer's Dement. 2023;19(1):58-88.
2. Hardy J, Selkoe DJ. The amyloid hypothesis of Alzheimer's disease: Progress and problems on the road to therapeutics. Science. 2002;297(5580):353-356.
3. Blennow K, Hampel H, Weiner MW, Zetterberg H. Cerebrospinal fluid and plasma biomarkers in Alzheimer's disease. Nat Rev Neurol. 2010;6(3):131-144.
4. Jagust WJ. Imaging the pathophysiology of Alzheimer's disease. Biol Psychiatry. 2013;74(6):433-439.
5. Sperling RA, Aisen PS, Beckett LA, et al. Toward defining the preclinical stages of Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimer's Dement. 2011;7(3):280-292.
6. Nelson PT, Alafuzoff I, Bigio EH, et al. Correlation of Alzheimer's disease neuropathologic changes with cognitive status: A review of the literature. J Neuropathol Exp Neurol. 2012;71(5):362-381.
7. La Joie R, Bejanin A, Fagan AM, et al. Amyloid and tau imaging, cerebrospinal fluid biomarkers, and clinical staging in Alzheimer's disease. JAMA Neurol. 2018;75(5):585-594.

8. Bennett DA, Schneider JA, Arvanitakis Z, et al. Neuropathology of older persons without cognitive impairment from two community-based studies. Neurology. 2006;66(12):1837-1844.
9. Jack CR, Knopman DS, Weiner MW, et al. Magnetic resonance imaging in Alzheimer's disease neuroimaging initiative (ADNI): Progress and outlook. Alzheimers Dement. 2010;6(2):207–219. doi:10.1016/j.jalz.2010.03.001.
10. Blennow K, Zetterberg H, Feldman HH, et al. The clinical use of cerebrospinal fluid biomarkers in the diagnosis of Alzheimer's disease. Alzheimer's & Dementia. 2015;11(2):58–75. doi:10.1016/j.jalz.2014.02.001.
11. Villemagne VL, Rowe CC, Pejoska S, et al. Early assessment of amyloid deposition in mild cognitive impairment with PET. Neurobiol Aging. 2011;32(8):1420–1427. doi:10.1016/j.neurobiolaging.2010.03.015.
12. Chai XJ, Schuff N, Zhang Z, et al. Synergistic effect of combining CSF biomarkers and PET imaging in the diagnosis of Alzheimer's disease. J Alzheimers Dis. 2016;50(1):75–85. doi:10.3233/JAD-150799.
13. Sperling RA, Aisen PS, Beckett LA, et al. Toward defining the preclinical stages of Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimers Dement. 2011;7(3):280–292. doi:10.1016/j.jalz.2011.03.003.
14. Cholerton BA, Abner EL, Nelson PT, et al. Cerebrospinal fluid biomarkers of Alzheimer's disease and mild cognitive impairment in a community sample of older adults. J Alzheimers Dis. 2011; 26(2):281–289. doi:10.3233/JAD-2011-110309.
15. Bennett DA, Schneider JA, Arvanitakis Z, et al. The neuropathology of Alzheimer disease: A review of the literature. J Neuropathol Exp Neurol. 2012;71(8):748–756. doi:10.1097/NEN.0b013e31826429f2.
16. Palmqvist S, Jöngren M, Mattsson N, et al. Plasma biomarkers of Alzheimer's disease in the community-based Swedish BioFINDER cohort. Alzheimer's & Dementia. 2019;15(9):1307–1315. doi:10.1016/j.jalz.2019.05.004.
17. Huang Y, Zhang L, Wang Z, et al. Artificial intelligence in imaging analysis for Alzheimer's disease: Current status and future perspectives. J Alzheimers Dis. 2020; 74(2): 305–319. doi:10.3233/JAD-200742.

Access this Article in Online	
	Website: www.ijcrims.com
Quick Response Code	Subject: Neuropathology
DOI: 10.22192/ijcrms.2025.11.02.005	

How to cite this article:
Gottipati Jayanth. (2025). Observational Study on the Role of Tau and Amyloid Biomarkers in Alzheimer's Disease Diagnosis at Tertiary Care Hospital. Int. J. Curr. Res. Med. Sci. 11(2): 38-44. DOI: http://dx.doi.org/10.22192/ijcrms.2025.11.02.005