PET-validated EEG-Machine Learning Algorithm Predicts Brain Amyloid Pathology

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BACKGROUND / PREMISE

The use of PET as the initial or sole biomarker of β-amyloid (Aβ) brain pathology may inhibit Alzheimer's disease (AD) drug development and clinical use due to cost, access, and tolerability.[1]

Machine learning (ML)-based EEG biomarkers may address these challenges. Previous studies have confirmed their ability to accurately discriminate between normal, mild cognitive impairment (MCI) and Alzheimer's dementia.[2]

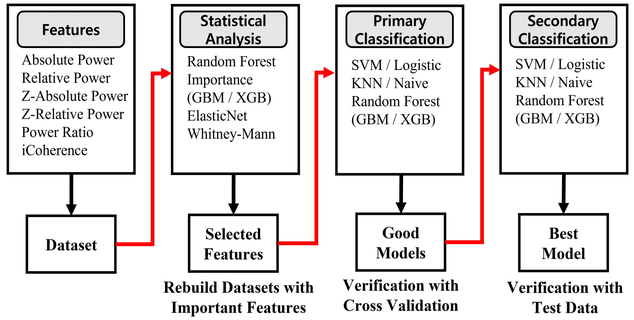
We developed a qEEG-ML algorithm to predict brain Aβ pathology among subjective cognitive decline(SCD) and MCI patients, and validated it using Aβ PET.

BRIEF / MAIN MATHOD

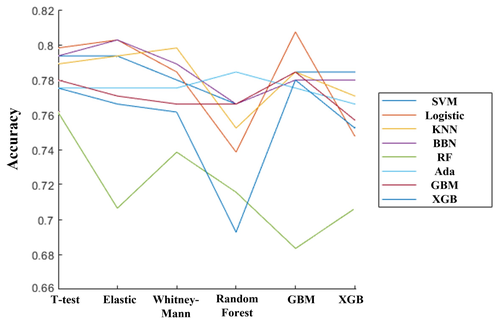
EEG (19-channel, eye-closed, resting-state) and Aβ PET data were collected from 311 human subjects. SCD (Aβ+: N=36, Aβ-: N=160) or MCI (Aβ+: N=54, Aβ-: N=61). We kept 76 random data (25%) for validation.

QEEG absolute power, relative power, power ratio, and connectivity between channels(iCoherence) comprised the input features, from which the most relevant predictive features were identified using 4 different statistical analysis.

We trained 6 ML algorithms using each relevant feature set, yielding 24 models (4 feature sets * 6 algorithms). The 76 validation data sets were input into each model to compare their performance.



Schematic plot of feature selection with statistical analysis and validation process.



Graph showing accuracy of every feature set and ML algorithm combination.

KEY FINDINGS

The best-performing model (random forest importance * ensemble tree) showed 82.9% accuracy, 90.9% sensitivity, 76.7% specificity, and 75% positive predictive value in discriminating Aβ+ from Aβ-, both MCI/SCD.

MCI alone, 82.1% accuracy, 90.0% sensitivity, 78.9% specificity, and 81.8% positive predictive value. SCD alone, 81.1% accuracy, 92.3% sensitivity, 75% specificity, and 66.7% positive predictive value.

	SCD+MCI		SCD only		MCI only	
	True Aβ+	True Aβ-	True Aβ+	True Aβ-	True Aβ+	True Aβ-
Predicted Aβ+	30	10	12	6	18	4
Predicted Aβ-	3	33	1	18	2	15

CONCLUSIONS

These findings suggest that our novel ML-based qEEG biomarker can accurately predict the presence of brain Aβ plaque.

Additional benefits of such a biomarker include reduced expense, wide availability, and high-throughput screening and response monitoring.

Future studies will assess utility as primary AD screens, adjunctive use with PET, and as a support in clinical rationales for Aβ PET and treatment choice in AD.

SUMMARY

Fine classification for β-amyloid accumulation in the brain based on QEEG is possible.

QEEG can play an important role in that it is more accessible, cost-effective than PET test.

REFERENCES

[1] Braak, H, et al. "Staging of Alzheimer's disease-related neurofibrillary changes." *Neurobiol. Aging* (1995)
[2] I.A. van Rossum, et al.). "Injury markers predict time to dementia in subjects with MCI and amyloid pathology". *Neurology* (2012)

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