Machine Learning to Predict Brain Amyloid pathology in Alzheimer's Disease Using QEEG

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Frontiers in Computational Neuroscience 11 December (2021): 10.3389.

Purpose

- Alzheimer's' disease(AD) is the most common cause (nearly 70%) of worldwide dementia.
- Alzheimer's disease is difficult to diagnose in its early stages because the cognitive decline can be subtle. At the same time, Beta-amyloid is a well-characterized diagnostic index of AD and its accumulation cabe used to predict progression from mild cognitive impairment(MCI) to dementia.
- Although Cerebrospinal fluid and positron emission tomography (PET) biomarkers, combined with relatively new clinical criteria, can help diagnose AD, they are both invasive and costly.
- Therefore, EEG find AD biomarkers using less invasive biomarkers.
- This study, the presence or absence of amyloid in the neurodegenerative diseases(Subjective Cognitive Decline(SCD), Mild Cognitive Impairment(MCI)) is determined and used as basic information for biomarker studies that can diagnose early Alzheimer's disease in the future.

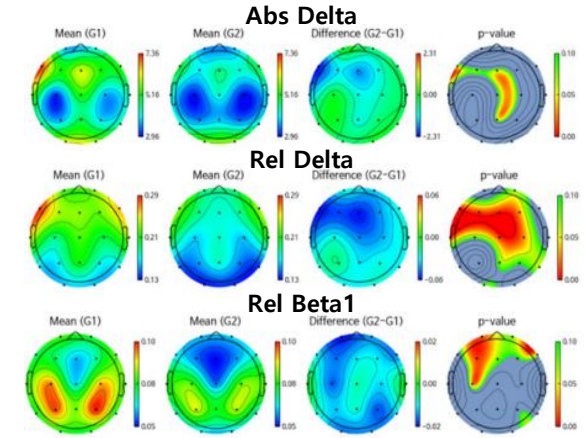
Subjects / Methods

	SCD (+)	SCD (–)	MCI (+)	MCI (–)	Total
Institution A	16	69	9	14	108
Institution B	18	77	20	20	135
Age (mean ± sd)	72.0 ± 5.9	71.3 ± 6.9	74.5 ± 6.1	71.5 ± 6.8	71.8 ± 6.7
Gender (M/F)	18/16	94/52	18/11	15/19	145/98
Total	34	146	29	34	243

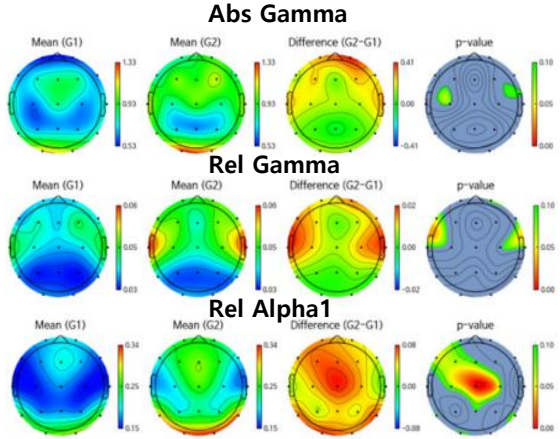
- Collection of 243 data
- EEG analyzing Artificial intelligence 'iSyncBrain' understands Genetic Algorithm Heuristic and goes through machine learning based on the quantified analysis values generated from each of the 19 channels' frequency bands[Delta(1-4Hz), Theta(4-8Hz), Alpha1(8-10Hz), Alpha2(10-12Hz), Beta1(12-15Hz), Beta2(15-20Hz), Beta3(20-30Hz), Gamma(30-45Hz)].

Results

[amyloid positive group vs negative group paired t-test]



Absolute Power – Delta / Relative Power – Delta, Beta1 amyloid positive group was strong.



Absolute Power – Gamma / Relative Power – Gamma, Alpha1 Amyloid positive group was strong.

[Results from the Model]
- Production of five-dimensional model by combining top-level features selected by the genetic algorithm.
- Filtration of models with the accuracies of more than 80% after going through a process of cross-validation.
- Selection of the best classification model among the filtered models.

SCD	True positive	True negative	MCI	True positive	True negative
Predicted positive	6	3	Predicted positive	5	1
Predicted negative	1	25	Predicted negative	1	6

SCD(Subjective Cognitive Decline) – sensitivity: 85.7%, specificity: 83.8%, accuracy: 88.6%
MCI(Mild Cognitive Impairment) – sensitivity: 83.3%, specificity: 85.7%, accuracy: 84.6%

Discussion

- Implies that Genetic Algorithm Heuristic is useful when QEEG selects features.
- Utilizing QEEG analyzation that uses Genetic Algorithm Heuristic, the accumulated amount of Beta-amyloid can be checked.
- According to the result of the experiment, Beta-amyloid can be expected to be a promising biomarker for the early Alzheimer's disease in the future.
- As a result, since QEEG has higher accessibility and is more beneficial than PET, QEEG is expected to play a significant role in disease diagnosis and treatment.