

# 알츠하이머형 치매 환자 뇌파의 비선형 역동 분석\*

- 상관차원을 이용한 예비적 연구 -

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## Nonlinear Dynamic Analysis in EEG of Alzheimer's Dementia\*

- A Preliminary Report Using Correlation Dimension -

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### ABSTRACT

The changes of electroencephalogram(EEG) in patients with dementia are most commonly studied by analyzing power or magnitude in certain traditionally defined frequency bands. However because of the absence of an identified metric which quantifies the complex amount of information, there are many limitations in using such a linear method. According to chaos theory, irregular signals of EEG can also result from low dimensional deterministic chaos. Chaotic nonlinear dynamics in the EEG can be studied by calculating the correlation dimension. The authors have analyzed EEG epochs from three patients with dementia of Alzheimer type and three matched control subjects. The multichannel correlation dimension is calculated from EEG epochs consisting of 15 channels with 16,384 data points per channel. The results showed that patients with dementia of Alzheimer type had significantly lower correlation dimension than non-demented controls on 12 channels. Topographic analysis showed that the correlation dimensions were significantly lower in patients with Alzheimer's disease on frontal, temporal, central, and occipital head regions. These results show that brains of patients with dementia of Alzheimer type have a decreased complexity of electrophysiological behavior. We conclude that the nonlinear analysis such as calculating correlation dimension can be a promising tool for detecting relative changes in the complexity of brain dynamics.

**KEY WORDS** : Dementia of Alzheimer type · Chaos · Nonlinear · Dynamic · EEG · Correlation dimension.

서 론

가 50 60% (Kaplan 1994).

(老人斑 ; senile plaque) (neurofibrillary tangle)

(Khachaturian 1985), 가

(McKhann 1984).

60 80%

(Woyshtville Calabrese 1994).

1997 가 1996

가

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† : , 301 - 012 2 520 - 2, ) (042) 220 - 9565, ) (042) 221 - 4776 (Soininen 1982).

가  
(Markand 1984),

(Signorino 1995).

가  
1988 ; Coben 1990).  
, 가  
(linear model)

가  
(Woyshville Calabrese 1994).

( 1)  
(Pradhan Dutt 1993).

가  
가

(Gleick 1987).

가  
가 ,

가 ( 1995).

(Mandell Selz 1992).  
Babloyantz (1985)

가 가 가  
가 가  
가

## 연구대상 및 방법

### 1. 연구대상

가 65

(Brenner  
( 1989)  
가 24 가

가  
chinski (Rosen 1980) 4  
DSM - IV(American  
Psychiatric Association 1994)  
NINCDS - ADRDA(McKhann 1984)

3

25

가  
가 3

### 2. 뇌파의 측정과 디지털화

Nihon Kohden EEG - 4421K  
0.1 , 7  $\mu$ V/mm, 35Hz  
10 20  
F3, F4, F7, F8, Fp1, Fp2, T3, T4, T6, C3, C4, P3, P4, O1,  
O2 15 . A1/A2  
가

32.678 500Hz

### 3. 상관차원(correlation dimension : 부록 2) 계산과 비교

16,384(500Hz x 32.678 ) 가

Grassberger - Procaccia

C

( 1996).

**Table 1.** Comparison of correlation dimension of patients with dementia of Alzheimer's type and control subjects (Mann-Whitney U-Wilcoxon rank sum W test)

Location	Dementia of alzheimer's type(N=3)		Control(N=3)		z	P
	Mean	SD	Mean	SD		
F3	9.96	1.34	10.51	0.42	0.65	NS
F4	8.84	0.23	10.28	0.28	1.96	<0.05
F7	9.14	0.27	9.78	0.21	1.96	<0.05
F8	7.94	0.14	9.07	0.30	1.96	<0.05
Fp1	9.35	0.24	9.65	0.20	1.55	NS
Fp2	8.11	0.70	9.31	0.12	1.96	<0.05
T3	9.50	0.02	10.32	0.09	1.96	<0.05
T4	8.44	0.17	8.97	0.24	1.96	<0.05
T6	8.18	0.21	9.59	0.31	1.96	<0.05
C3	9.09	0.05	10.38	0.30	1.99	<0.05
C4	9.38	0.30	10.18	0.21	1.96	<0.05
P3	8.91	0.13	9.51	0.70	1.77	NS
P4	8.88	0.23	9.60	0.08	1.99	<0.05
O1	7.17	0.74	9.74	0.30	1.96	<0.05
O2	9.09	0.12	10.18	0.43	1.96	<0.05

NS : Not significant

Kahn (1993)

(Fp1, Fp2, F3, F4), (F7, F8, T3, T4, T6), (C3, C4) (P3, P4, O1, O2)

가 가

가

SPSS

가

Mann - Whitney U - Wilcoxon rank sum W p<0.05

nk sum W

## 결 과

66.7 ± 4.1

11.3 ± 2.5

69.3 ± 3.1

27.3 ± 0.6

15

3

F3,

(Leuchter 1987).

가

가

(Table 1, Fig. 1).

가

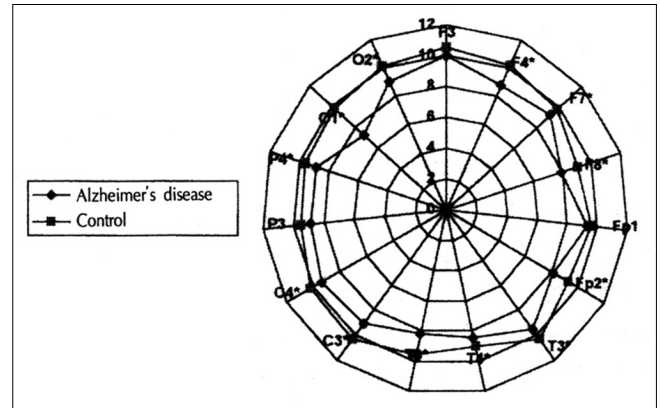
(Brenner 1986 ; Markand 1984 ; Soinin

(Ta - 1991).

ble 2).

가

(Isse



**Fig. 1.** Correlation dimension of patients with dementia of Alzheimer's type and control subjects by multichannel EEG (\* : P < 0.05).

**Table 2.** Comparison of correlation dimension of patients with dementia of Alzheimer's type and control subjects by topographic distribution (Mann-Whitney U-Wilcoxon rank sum W test)

Location	Dementia of Alzheimer's type(N=3)		Control(N=3)		z	P
	Mean	SD	Mean	SD		
Frontal	36.26	1.82	39.74	0.34	1.96	<0.05
Temporal	43.21	0.71	47.72	0.90	1.96	<0.05
Central	18.47	0.33	20.56	0.49	1.96	<0.05
Occipital	34.06	0.85	39.03	1.32	1.96	<0.05
Total	132.00	3.02	147.06	2.74	1.96	<0.05

**Table 3.** Comparison of correlation dimension of patients with dementia of Alzheimer's type and control subjects by hemispheres (Mann-Whitney U-Wilcoxon rank sum W test)

Hemisphere	Dementia of Alzheimer's type(N=3)		Control(N=3)		z	P
	Mean	SD	Mean	SD		
Left	63.12	1.79	69.88	1.69	1.96	<0.05
Right	68.87	1.27	77.18	1.05	1.96	<0.05

(Table 3).

## 고 찰

1990), 가 - (Stam 1994)  
(Mody 1991 ; Schreiter - Gasser 1993). 가 (Woyshville 1987 ;  
가 가 (Coben 1985 ; Woyshville Calabrese 1994) . (Fig. 1)  
Penttila 1985). REM  
(Petit 1992)  
가 (Breslau 1989 ; Leuchter 1987) (R=schke 1995<sub>a</sub> ; R=schke 1995<sub>b</sub>)  
(Besthorn 1994)가 .  
(Dierks 1991 ; Signorino 1995). 가 가  
가 가 ( 2)  
(Soininen 1982). 가 가  
1 (Gallez Babloyantz 1991). 가  
가 가  
가 (Soininen ( 1996). 가  
1989). 가 가  
가 가  
(Mayer - Kress Layne 1987). (Pritchard 1995), 가  
가 가  
(Babloyantz Destexhe 1986 ; Gallez Babloyantz 가 (R=schke  
1991 ; R=schke Aldenhoff 1991 ; R=schke Aldenhoff 1995<sub>b</sub>). ( 1996 ; R=s -  
1992), 가 가 (Ja - chke 1995<sub>a</sub>), ( 1997), ,  
nsen 1991), 가 가  
(Lutzenberger 1992) 가 가  
가 가  
3  
1994 ; 1995) (Be -  
3 sthorn 1995)  
(Prit -  
chard 1994) 가

가 M ( )  
(attr - actor)  
(Jansen 1991),

0 1 2  
가 가 가  
(準)

M ( )  
3 가 ( )

### 요 약

가 가 가 가 가  
가 가

3 3 3  
15 3  
Fourier

2. 상관차원(Gallez와 Babloyantz 1991 ; Stam 등 1994)  
( $D_2$ )

가  
부 록 가

1. 카오스 이론의 개요(McKenna 등 1994)

Hausdorff  
 $D_0$ 가 가

Takens

$F(t)$ 가  $t$ 가  
 $F(t), F(t+\tau), F(t+2\tau)$   
 가  
 가  
 (1996)

중심 단어 :

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