EEG and computed tomography in the investigation of patients with senile dementia

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SUMMARY Fifty-six patients with senile dementia of Alzheimer type and 84 normal elderly people were examined by EEG and computed tomography. In discriminant function analysis of the computed tomography indexes the highest discriminant function coefficient was for width of the third ventricle. Using computed tomography, the groups were correctly classified for 84% of the subjects. In discriminant function analysis of the EEG variables the highest discriminant function coefficient was for dominant occipital rhythm; the groups were correctly classified for 86% of the subjects. In discriminant function analysis of the width of the third ventricle, an index of cortical atrophy, the dominant occipital rhythm, age and sex, the width of the third ventricle had the highest discriminant function coefficient; the groups were correctly classified for 90% of the subjects.

During normal ageing, cerebral ventricles dilatate with increasing age.[1–3] Therefore, the value of computed tomography (CT) for evaluating brain atrophy is reduced in elderly people. Patients with senile dementia of Alzheimer type, however, differ from normal elderly people both in ventricular dilatation and in cortical atrophy.[4] The severity of dementia is correlated with ventricular dilatation but not with cortical atrophy.[4–8] CT indexes standardised for age may be useful for differentiating between brain atrophy associated with senile dementia and atrophy related to normal ageing.[9]

Increasing age is also associated with increasing frequency of EEG abnormalities.[10–13] The EEG alterations associated with senile dementia are accentuations of features seen in normal ageing.[11 14] Elderly patients with Alzheimers' disease differ from normal elderly people in EEG normality, over-all disturbance, dominant occipital rhythm, accentuation of theta and delta waves, fluctuations in alertness, paroxysmal activity, and H-reaction.[12] Several studies have shown that frequency of the dominant occipital rhythm becomes slower with increasing intellectual impairment.[7 12 15 16]

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The purpose of the present study was to evaluate, using discriminant function analysis, the value of CT and EEG in differentiating between patients with senile dementia of Alzheimer type and normal elderly people.

Material and methods

Patients Fifty-six patients with senile dementia of Alzheimer type (44 females and 12 males, mean age 78 ± 6 years) were examined using CT and EEG. All the patients had progressive deterioration of intellect, memory, and personality.[17] Patients with symptomatic causes of dementia or cerebrovascular disease were excluded.[4] The intellectual status of the patients and the controls was determined by a neuropsychologist. The patients had moderate to severe dementia.[4]

Controls The controls were 84 normal elderly people, 63 female and 21 male volunteers (mean age 74 ± 7 years). Controls underwent the same examinations as did the patients, and had no neurological disease nor did they show signs of intellectual impairment.

EEG examination The electroencephalograms were recorded using an International 10–20 system for attaching the surface Ag/AgCl electrodes, and by recording for 30 minutes with a 16-channel Elema Mingograph EEG apparatus. Recordings were made by a trained EEG nurse. Photostimulation was also included in the examination.

EEG analyses were done "blindly", (that is with no information whether a given EEG belonged to a patient or to a control person) by an experienced clinical

neurophysiologist. EEG recordings were evaluated for normality, considering all the pathological findings established; four different grades were used (see below). The average frequency of the dominant occipital rhythms was measured in several points of the specimen. In addition, we evaluated over-all disturbance, accentuation of theta and delta rhythms as compared with normal, intensity of the fluctuations in alertness, asymmetric findings, paroxysmal activity, and H-reaction in the photostimulation. Each variable was graded according to intensity (0 = normal, 1 = doubtful finding, 2 = obvious finding, 3 = marked finding) and submitted to computer analysis.

CT examination All CT examinations were made by a third generation, rotatefan beam scanner (Somatom 2, Siemens). The image matrix was 256 × 256. Scan parameters were: time 10 seconds, slice thickness 8 mm, 125 kv, 230 mAs. Contrast enhancement was not used. The level of the first scan was at the base of the skull, through the fourth ventricle parallel to the orbotomeatal line. The number of scans per patient was 8–12 without overlapping.

Measurement: patient history and other clinical data were unknown during measurement. Precision of measurement was high, because it was made from floppy discettes by an electronic measuring program, which gave all linear dimensions in millimetres. Reliability of measurement was tested with a small random sample of cases (15 patients or controls); the reliability coefficient was over $r = 0.96$ for all parameters.

We used the following parameters (see fig):
1   FHI = frontal horn index = ratio of maximal width of frontal horns and maximal width of skull at the same level.
2   CMI = cella media index = ratio of minimal width of lateral ventricles in cella media region and width of outer skull table at the same level.

3   III ventricle = maximal width of the third ventricle.
4   CI = index of cortical atrophy = mean of the four largest sulci from the highest cut.

Statistical analysis The data was analysed using a computer program for discriminant function analysis.

Results

In the discriminant function analysis of the CT variables FHI, CMI, width of the third ventricle and index of cortical atrophy and age and sex, the highest discriminant function coefficient was for width of the third ventricle (table 1). The coefficients for FHI and CMI were diminished by the high correlation between width of the third ventricle and FHI ($r = 0.66$) and CMI ($r = 0.63$) and between FHI and CMI ($r = 0.65$). Using this analysis 46 (81%) patients with senile dementia of Alzheimer type were correctly classified and 10 (19%) were wrongly classified. Seventy-three (87%) of the controls were correctly classified. Of the grouped cases, 84% were correctly classified.

In discriminant function analysis of the EEG variables: dominant occipital rhythm, accentuation of theta and delta, fluctuation in alertness, asymmetric findings, paroxysmal activity, and H-reaction, and age and sex, the highest coefficient was for dominant occipital rhythm (table 2). Using this analysis 82% of the patients were correctly classified; 89% of the controls were correctly classified. Of the grouped cases 86% were correctly classified.

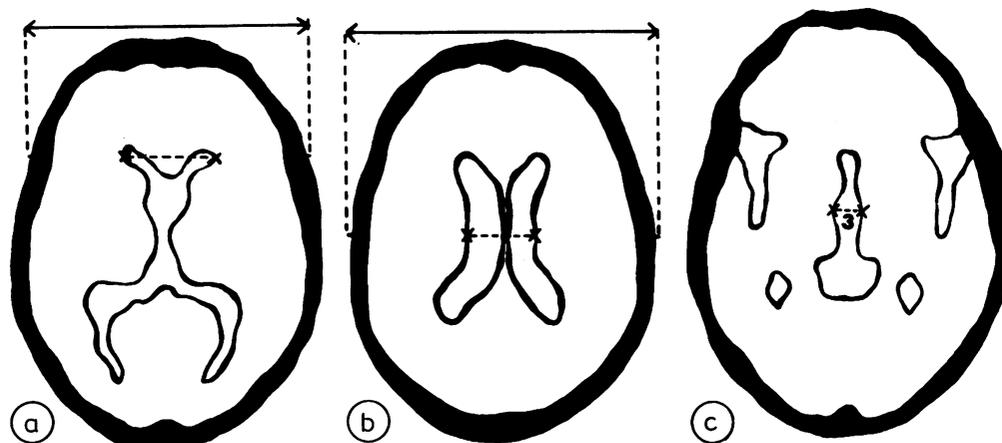When width of the third ventricle, index of cortical atrophy, dominant occipital rhythm, age, and sex

Figure   *CT scan sections used for various measurements in this study. (a) Frontal horn index = ratio of maximal width of frontal horn to maximal width of skull at the same level. (b) Cella media index = ratio of minimal width of lateral ventricles in cella media region to width of outer skull table at the same level. (c) Maximal width of the third ventricle.*[3]

Table 1 *Discriminant function coefficients and their standard errors for CT indexes between patients with senile dementia of Alzheimer type and normal elderly people*

	Discriminant function coefficient	Standard error
III†	−0·596*	0·014
CMI	−0·499	1·062
CI	−0·120*	0·015
FHI	+0·006	0·851
Sex	−0·164*	0·069
Age	+0·080*	0·004

*p < 0·05.
†III = width of the third ventricle, CMI = cella media index, CI = index of cortical atrophy, FHI = frontal horn index.
n = 56 for patients.
n = 84 for controls.

Table 3 *Discriminant function coefficients and their standard errors for width of the third ventricle (III), index of cortical atrophy (CI), dominant occipital rhythm, age and sex between patients with senile dementia of Alzheimer type and normal elderly people*

	Discriminant function coefficient	Standard error
III	−0·642*	0·010
Dominant occipital rhythm	+0·624*	0·025
CI	−0·094*	0·014
Age	+0·230*	0·004
Sex	−0·199*	0·065

*p < 0·05.
n = 56 for patients.
n = 84 for controls.

Table 2 *Discriminant coefficients and their standard errors for EEG variables between patients with senile dementia of Alzheimer type (SDAT) and normal elderly people*

	Discriminant function coefficient	Standard error
Dominant occipital rhythm	−0·634*	0·026
Accentuation of theta and delta	+0·409*	0·040
H-reaction	+0·385*	0·038
Paroxysmal activity	−0·119	0·060
Fluctuations in alertness	−0·022	0·042
Asymmetric findings	+0·006	0·036
Sex	+0·065	0·063
Age	−0·138*	0·004

*p < 0·05.
n = 56 for patients.
n = 84 for controls.

were chosen as variables for the discriminant function analysis, the highest discriminant function coefficient was again for width of the third ventricle (table 3). According to this analysis 46 (86%) patients and 78 (93%) controls were correctly classified. As a whole, correct classification was achieved in 90% of the subjects.

Discussion

There is some overlapping in CT and EEG findings for patients with senile dementia of Alzheimer type and normal elderly people. In this study use of both CT and EEG for differentiation between the groups, 90% were correctly classified. With EEG alone, 86% were correctly classified. Thus, EEG is a valuable screening tool for evaluating the possibility of dementia, especially for differential diagnosis between pseudodementia associated with depression and organic dementia. Fox *et al* [18] and Merskey *et al* [19] suggested that EEG correlates better with the severity of dementia in its early stages; while CT correlates better with the degree of intellectual impairment in advanced cases.

Diagnosis of dementia is always a clinical one and cannot be based on CT and EEG findings alone.

When an elderly person with clinical manifestations of dementia has no cerebral atrophy demonstrable on CT scan, the symptomatic causes of dementia and metabolic toxic, infectious, or psychiatric disorders should be pursued.[20] Of the variables used in this study, the highest discriminant function coefficient was for width of the third ventricle. Use of this parameter of central atrophy (standardised for age) might be helpful in differentiating between atrophy associated with senile dementia and atrophy related to normal ageing.

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