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Cerebellar Vermal Atrophy in Psychiatric Patients

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Our findings indicate that a notable number of patients who have functional psychosis (50%) or seizures (38%) show cerebellar vermal atrophy on visual inspection of CAT head scans, in contrast to 0.5% to 3.7% of patients with other disorders. In addition to the visual reading of 1700 scans in the present study, we used two methods to demonstrate cerebellar vermal atrophy objectively: (i) low-density measurements of the posterior fossa in relationship to total brain area, and (ii) sagittal reconstruction of the vermis. We postulate that cerebellar vermal atrophy reduces the cerebellum's inhibitory influences on activity of the rostral forebrain structures where unit overactivity has been correlated with emotional dyscontrol and clinical seizures. We further postulate that cerebellar vermal atrophy reduces facilitory activity of the brain's pleasure system (septal region).

INTRODUCTION

We previously reported a high incidence (up to 40%) of pathologic change in the cerebellar vermis in patients diagnosed and treated as functional psychosis (Heath *et al.*, 1979). The most common aberration was vermal atrophy, but a few patients had other anomalies such as mucomycosis and tumors invading the vermis. Weinberger *et al.* (1979) have reported a high incidence of cerebellar

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enlarged on the scan, depicting the superior cerebellar surface (identified by the presence of the pineal body or the choroid plexus, or both). Any portions with CAT density of 24 were highlighted, and regions with a density of 24 or less were measured planimetrically. Three separate measurements were made: the area on the cross-section representing the superior cerebellar cistern, the sum of any other areas within the vermis with densities of less than 24, and the total cross-sectional area of the brain for this scan level. Based on these measurements, three quantities were calculated: area of superior cerebellar cistern as a percentage of total brain area, area of low-density fluid in the vermis as a percentage of total brain area, and the sum of these two areas as a percentage of total brain area. The third value – the sum of the two areas – was most indicative of the degree of cerebellar vermal atrophy and this is the figure we therefore use in presenting results.

Finally, to provide still more objective measures of vermal atrophy, preliminary studies involving high-precision midsagittal CAT reconstructions were also conducted. Using a Picker Synerview, sagittal reconstructions were obtained. The program was carried out on conventional scans read as showing cerebellar vermal atrophy, as well as on scans read as normal. Thirty-two CAT cuts of 2-mm width were used to provide the reconstruction which displayed, in saggital section, the outline of the vermis from which precise measures could be made.

CAT Scan–Anatomical Correlation

To establish correlations between the CAT scan and gross pathologic change, we obtained photographs of the cerebellum of three patients from whom scans had been obtained previously. Two were photographed during cerebellar implantation procedures (a sagittal reconstruction of the head scan was also made of one of these patients), and the third was obtained after death.

RESULTS

Visual Interpretation of Scans

Scans of 25 of the 50 schizophrenic patients (50%) were considered to show cerebellar vermal atrophy, all but one of the 25 having been graded as at least 2+ (Table I).

Scans of 34 of the 64 patients who had a diagnosis of functional psychosis other than schizophrenia (53%) were interpreted as showing atrophy of the vermis in otherwise normal scans; 23 of the 34 were graded as at least 2+, and 11 were graded as 1+.

Table III. Cerebellar Vermal Atrophy – Visual *vs.* Computer Readings

Type of reading	Number of scans (n = 60)			
	Total without atrophy	Total with atrophy	Cerebellar vermal atrophy plus generalized atrophy	Cerebellar vermal atrophy only
Visual	31	29	14	15
Computer	38	22	14	8[a]

[a] Number includes two false-positives.

scans, 29 showed cerebellar vermal atrophy on visual inspection (Table III). On 14 of these 29 scans, gross generalized atrophy (including enlarged ventricles and cortical sulci characteristic of organic brain syndrome) was evident in addition to cerebellar vermal atrophy. In each of these instances, the cerebellar vermal atrophy was noted on both visual inspection and computer reading, but there was some discrepancy between visual inspection and computer reading of scans showing atrophy confined to the vermis.

The two methods (visual inspection and computer reading) were in agreement on 49 of the 60 scans. Of the 11 in which there was a discrepancy, 9 that were graded by visual inspection to show cerebellar vermal atrophy only fell within the normal range on computer analysis. In the other two scans in which there was a discrepancy, the computer reading was abnormal, whereas the visual

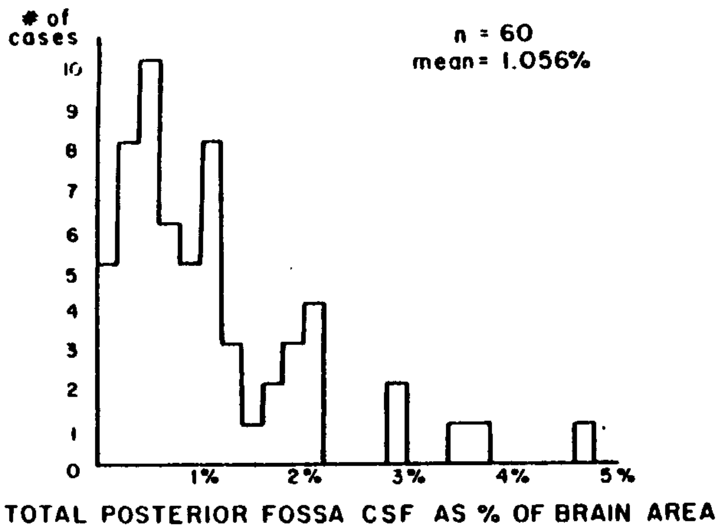

Fig. 1. Histogram showing distribution of patients according to ratio of posterior fossa low-density area/total brain area.

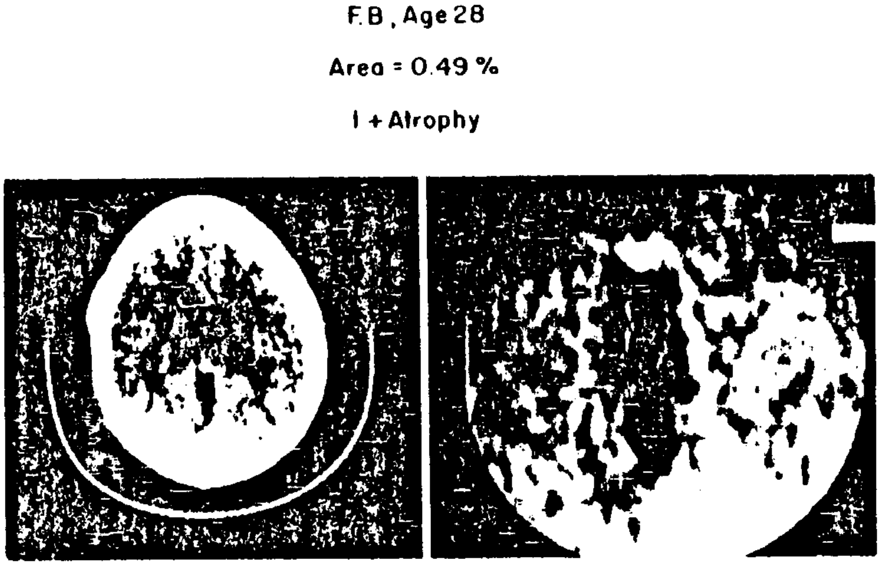

Fig. 3. CAT head scan rated as 1+ for cerebellar vermal atrophy by visual inspection and negative by the computer reading.

tion of this patient's CAT scan. For contrast, the sagittal reconstruction of a CAT scan from a nonpsychotic patient without cerebellar vermal atrophy is shown in Fig. 10.

Another CAT scan-anatomic correlation was obtained on a chronic schizophrenic patient who went to autopsy. Forty-eight years old, the patient had had

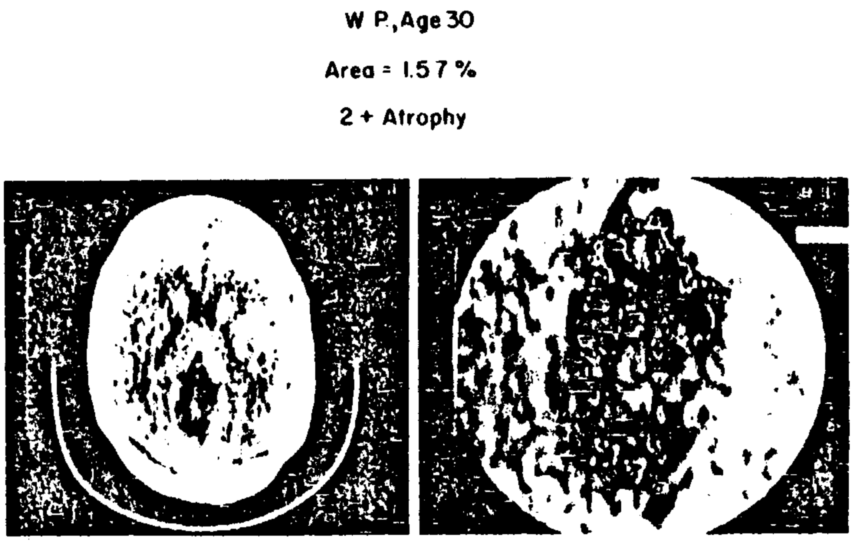

Fig. 4. CAT head scan in which cerebellar vermal atrophy was detected by both visual inspection and computer reading.

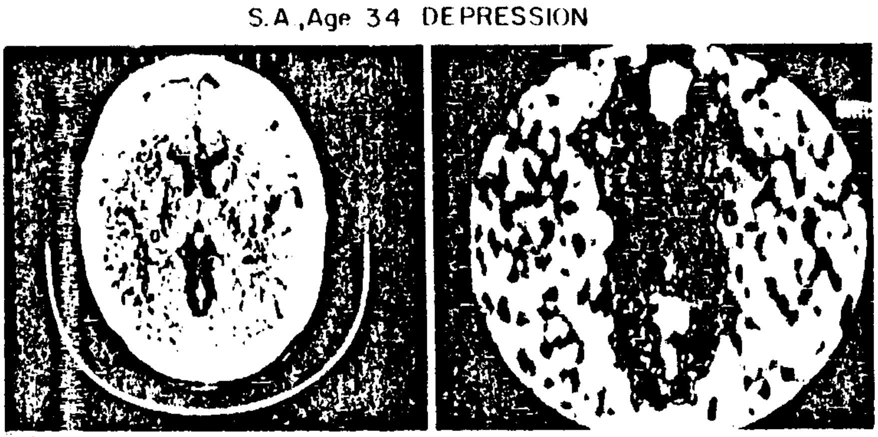

Fig. 7. Left: Conventional CAT head scan through the pineal and superior cerebellar surface read visually as 3+ for cerebellar vermal atrophy. Right: Low-density area outlined by cursor from magnified scan.

Fig. 8. This photograph, obtained at operation from the same patient whose CAT head scan is shown in Fig. 7, shows a profoundly shrunken midline cerebellum between the two lateral lobes. It constitutes a deep groove filled with cerebrospinal fluid and traversed by two large veins.

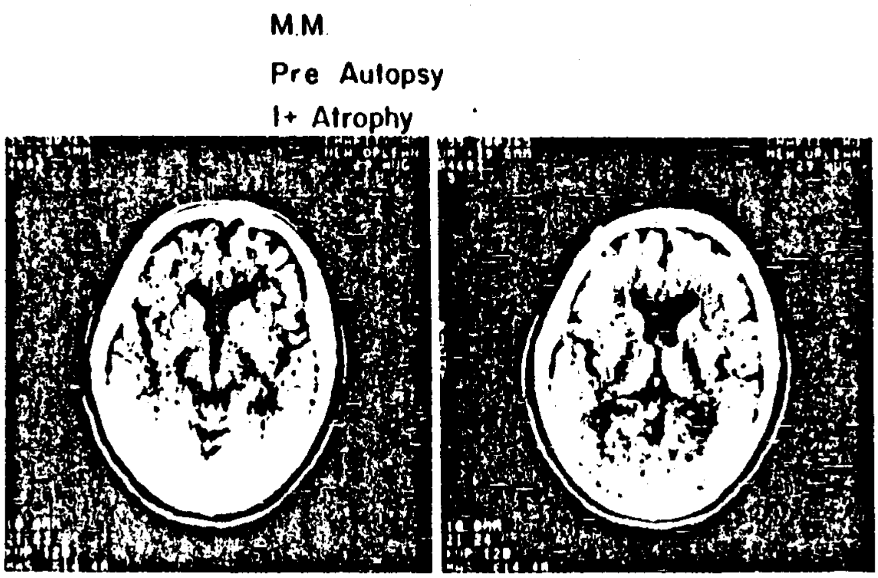

Fig. 11. In this CAT scan, note the enlarged sulcis over the rostral vermis and the enlarged low-density area over the caudal vermis. This patient also had generalized atrophy, as evidenced by minimal enlargement of the lateral ventricles and an increase in size of sulci markings of the frontal cortex.

multiple psychiatric hospital admissions over a period of 22 years. She died of a pulmonary embolus. Her CAT scan was considered to show borderline atrophy (1+) (Fig. 11). Figure 12, obtained after death, shows the patient's cerebellum to be relatively normal, with a suggestion of some atrophy rostrally and over the caudal vermis. Light microscopic examinations of the vermal tissue stained with H & E stain, Klüver stain, and thionin-fast green demonstrated no clear-cut abnormalities.

DISCUSSION

The present survey of CAT head scans obtained on a University Hospital Service indicates that cerebellar vermal atrophy is present in a significantly higher percentage of patients with schizophrenia, other functional psychoses, and seizural disorders than in patients with other diagnoses. We, as well as others, previously reported a high incidence of cerebellar vermal atrophy in schizophrenic patients (Heath *et al.*, 1979; Weinberger *et al.*, 1979). Current findings indicate the incidence is just as great in patients with other functional psychoses, particularly depression, and that it is unusually high in patients with seizural disorders.

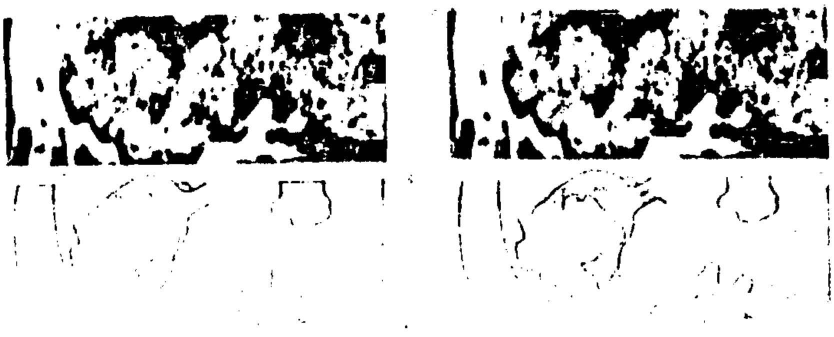

Fig. 13. Sketch of a sagittal reconstruction through the midline of the posterior fossa, demonstrating the potential for inconsistencies by computer readings. The dark shadow represents the area encompassed by the 10-mm cut of the conventional scan. Left: The entire 10-mm falls within the space over the superior surface of the vermis created by cerebellar vermal atrophy. This would show at the density of spinal fluid and would be read as cerebellar vermal atrophy. Right: In contrast, only 5 mm of the 10-mm cut encompasses the space, filled with spinal fluid, resulting from cerebellar vermal atrophy, while the other 5 mm of the cut encompasses brain tissue. The result would be a density reading by the computer higher than that of spinal fluid and the possibility of a false-negative reading. For abbreviations, see Fig. 9.

which CAT scan-anatomical correlations were made, visual inspection would appear to be fairly reliable. On the basis of our preliminary data, we are optimistic that use of planimetry on the sagittal reconstruction will provide the most reliable objective measurement of cerebellar vermal anomalies.

When cerebellar vermal atrophy is present, the shrinkage is in the dorsoventral plane. As a consequence, the lateral dimension or width of the vermis is unchanged and may even seem greater. One group of workers, in an attempt to establish an objective measure of cerebellar vermal atrophy, measured the width of the vermis and found no differences (Coffman *et al.*, 1981). Nor should any be expected, since this measure is not relevant.

The significance of cerebellar vermal atrophy to the clinical disorders of schizophrenia, depression, and seizures is not completely clear. Cerebellar vermal atrophy cannot be correlated with a specific diagnostic entity since it occurs with almost the same frequency in association with schizophrenia, psychotic depression, and seizural disorders. However, there does seem to be a correlation with symptoms characteristic of these disorders, such as a proneness to emotional dyscontrol, a deficiency in the pleasure mechanism (anhedonia), and a deficiency in self-awareness.

Some inferences can be drawn by relating findings in patients to animal experiments. Studies in patients with deep brain electrodes have indicated (Heath *et al.*, 1954; Heath, 1962, 1975) (i) impaired function of the septal region in association with anhedonia and grossly psychotic behavior; (ii) facilitated activity of the hippocampus that correlates with profound emergency emotion; (iii)

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