Corticobasal Degeneration: MR with Histopathologic Comparison

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Summary: The purpose of this study was to illustrate the MR findings of corticobasal degeneration and to compare those findings with pathologic specimens. MR findings of atrophy in the perirolandic gyri, atrophy of the basal ganglia, and T2 prolongation in the posterolateral putamen are useful evidence supporting the clinical diagnosis of corticobasal degeneration.

Index terms: Basal ganglia, diseases; Degenerative disease

Corticobasal degeneration is a slowly progressive disorder with a clinically asymmetric onset characterized by apraxia, dystonia, postural instability, and an akinetic-rigid syndrome that does not respond to levodopa (1–4). The characteristic neuropathologic findings are neuronal loss and numerous swollen achromatic neurons (2). These abnormalities are found throughout the brain, but predominate in the frontoparietal cortex and in subcortical areas such as the striatum and substantia nigra (1–5). Magnetic resonance (MR) imaging has shown asymmetric atrophy in the precentral and postcentral gyri with thinning of the cerebral cortex in those regions.

We identified three patients with clinical and radiologic findings consistent with corticobasal degeneration, including one in whom pathologic confirmation was obtained. Two of the three patients had atrophy of the basal ganglia.

Case Reports

Three patients, all right-handed, with a diagnoses of probable corticobasal degeneration based on clinical criteria were studied by MR imaging. Age at onset of the disease was 52 to 64 years. Disease duration was 4 to 5 years. Each patient fulfilled the following criteria (1, 2): asymmetric onset of the disease (one right-sided, two left-sided); parkinsonism (akinesia, rigidity) with lack of response to levodopa; apraxia, alien limb sign; and progressive evolution.

The MR studies of all three patients revealed marked dilatation of the central sulci and superior-frontal sulci with cortical thinning in the precentral and postcentral gyri that was asymmetric (Fig 1A and B). The predominant side of atrophy was always contralateral to the clinically affected side. There were multiple linear-shaped areas of T2 prolongation (Fig 1C) in the subcortical white matter in the affected parietal region. Bilateral symmetric atrophy of the basal ganglia was seen in two of the three patients (Fig 2); curvilinear T2 prolongation was present at the posterolateral edge of the putamen (Fig 1D). Abnormal signal intensity was not apparent in the claustrum of the patient who subsequently underwent autopsy. There were no obvious signal or structural abnormalities in the thalami, substantia nigra, or periaqueductal areas (Fig 1E). No atrophy was identified in the hippocampi of any of the three patients. The MR studies did not show the characteristic circumscribed frontotemporal atrophy of Pick disease, or atrophy of the brain stem characteristic of progressive supranuclear palsy.

The autopsy report showed an intact circle of Willis without evidence of atherosclerosis. Asymmetry of the cerebral hemispheres (the right was smaller than the left) was evident at the convexity, especially in the paracentral area (Fig 1F and G). Although the corticomedullary junction was distinct, the subcortical white matter of the affected area in the right hemisphere exhibited mild brown discoloration. The basal ganglia and thalami were symmetrically situated without any discoloration or softening-(Fig 1G). No abnormalities were noted in the cerebellar folial pattern, the cerebellar white matter, or nuclei. Multiple horizontal sections of the midbrain, pons, and medulla oblongata revealed the substantia nigra to be mildly depigmented (Fig 1H).

On histologic examination of the cerebrum, moderate degeneration was noted in the affected areas, consisting of neuronal loss with occasional neuronal achromasia and gliosis involving the entire thickness of the cortex (Fig 1I and J). Gliosis was also noted in the subcortical white matter. Although a moderate number of neurofibrillary tangles and senile plaques were seen in the hippocampal

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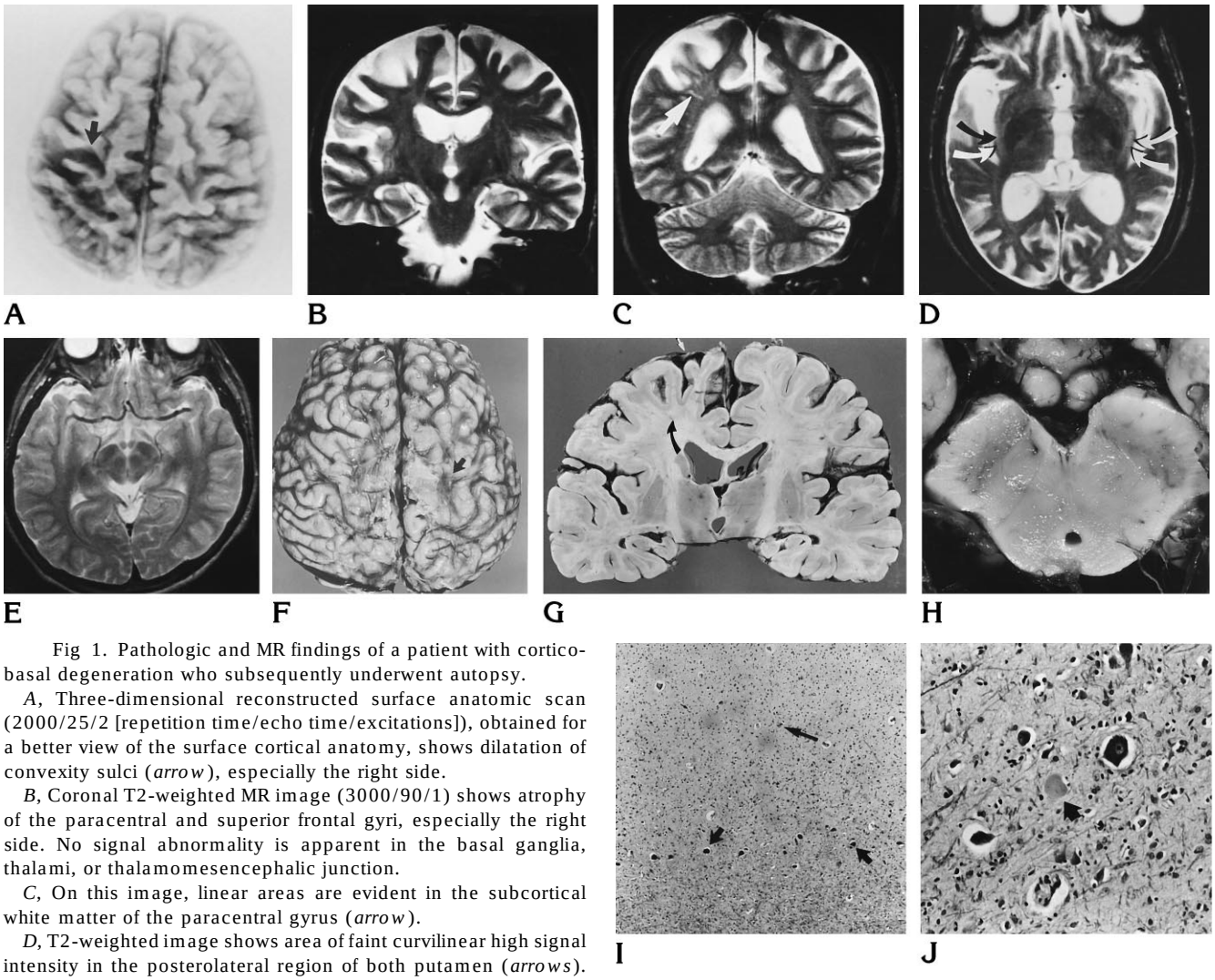

Fig 1. Pathologic and MR findings of a patient with corticobasal degeneration who subsequently underwent autopsy.

A, Three-dimensional reconstructed surface anatomic scan (2000/25/2 [repetition time/echo time/excitations]), obtained for a better view of the surface cortical anatomy, shows dilatation of convexity sulci (*arrow*), especially the right side.

B, Coronal T2-weighted MR image (3000/90/1) shows atrophy of the paracentral and superior frontal gyri, especially the right side. No signal abnormality is apparent in the basal ganglia, thalami, or thalamomesencephalic junction.

C, On this image, linear areas are evident in the subcortical white matter of the paracentral gyrus (*arrow*).

D, T2-weighted image shows area of faint curvilinear high signal intensity in the posterolateral region of both putamen (*arrows*). This characteristic was seen in two of our three patients.

E, T2-weighted axial MR image (3000/90/1) at the midbrain level shows no evidence of signal abnormality in the substantia nigra or red nucleus.

F, Gross anatomy of the brain shows cerebral atrophy, especially of the paracentral gyri (*arrow*).

G, Coronal whole-brain section shows asymmetry of cerebral hemispheres, with atrophy predominately in the paracentral area (*straight arrow*). Although the corticomedullary junction was distinct, the subcortical white matter of the right cerebrum exhibited mild brown discoloration (*curved arrow*). Parahippocampal gyri and hippocampi are normal.

H, Macroscopic specimen at midbrain level shows substantia nigra is mildly depigmented.

I, Microscopic specimen of the motor cortex shows diffuse cortical gliosis (*long arrow*) with relative preservation of Betz cells (*short arrows*).

J, Microscopic specimen shows neuronal achromasia (*arrow*) in the layer of Betz cells in the primary motor area, which is typical of corticobasal degeneration.

and parahippocampal areas, no marked atrophic change was found in the hippocampus. The neurons in the basal ganglia were unremarkable, except for the claustrum, which showed occasional neuronal achromasia. Mild loss of pigmented neurons with occasional melanin-containing macrophages was noted in the substantia nigra. The thalamus, hypothalamus, pons, medulla oblongata, and cerebellum were unremarkable.

Discussion

Corticobasal degeneration is a slowly progressive disorder with onset characterized by asymmetric apraxia, dystonia, postural instability, and an akinetic-rigid syndrome that does not respond to levodopa (1–4). This clinicopathologic entity was described by Rebeiz et al

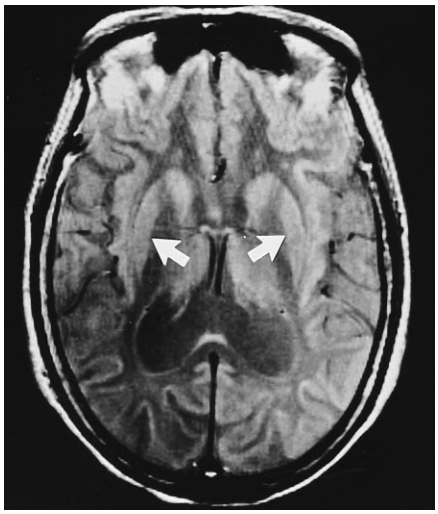

Fig 2. Proton density–weighted MR image (3000/15/1) of a different patient shows symmetric, bilateral atrophy in putamen (*arrows*).

(1) in three patients; these authors called the disorder *corticonigral degeneration with neuronal achromasia*. Achromatic swollen neurons was one of the characteristic pathologic abnormalities of the disorder. Their cases could not be clinically categorized within the spectrum of multiple-system atrophy or Parkinson disease because both cortical and extrapyramidal signs were present. Other reports suggested that this disease was sometimes vaguely reminiscent of progressive supranuclear palsy, Pick disease, and progressive subcortical gliosis (2, 4, 6).

In our cases, MR images showed asymmetric cortical atrophy in the precentral, postcentral, and superior frontal cortex. This localized asymmetric atrophy in the frontoparietal region has not been recognized in multiple-system atrophy, Parkinson disease, progressive subcortical gliosis, or progressive supranuclear palsy (7). Circumscribed parietal atrophy has been noted in only two of some 250 pathologic reports of Pick disease (8, 9). In our case in which autopsy was performed, Pick bodies were absent, the shrunken frontoparietal gyri had volume loss of both gray and white matter, and characteristic achromatic swollen cells were present in the cortical layers (Fig 1J).

Although cortical signs were present in all patients in this series (eg, motor apraxia, alien hand), it was difficult to ascertain the region(s) responsible for them because of the associated rigidity and involuntary movement resulting from the deep cerebral nuclear degeneration. The region responsible for motor apraxia has been considered to be the paracentral gyrus; however, some investigators have speculated that the supplementary motor area may have an important role in motor apraxia (10). Our three cases showed obvious atrophy in both the paracentral gyri and the superior frontal gyri, where the supplementary motor area is located. Alien hand is another sign frequently observed in patients with corticobasal degeneration. The lesions responsible for this manifestation are believed to occur in the supplementary motor area (11).

Areas of T2 prolongation were noted in the white matter deep to the affected gyri in our cases. These areas most likely reflect the gliosis seen in the autopsy specimen. Although this is not a specific finding for corticobasal degeneration, it is an important secondary sign, resulting from the overlying cortical degeneration.

Gibb et al (2) noted that other areas with predilection for cell loss and gliosis in corticobasal degeneration are the lateral thalamic nucleus, globus pallidus, claustrum, subthalamic nucleus, red nucleus, substantia nigra, locus ceruleus, and, occasionally, other brain stem nuclei (1–6, 12). The bilateral atrophy of the basal ganglia with curvilinear T2 prolongation in the posterolateral putamen noted in two of our patients most likely reflects these pathologic changes; further studies will be necessary to determine whether this finding is specific for corticobasal degeneration. However, pathologic changes in the deep cerebral nuclei are variable in reported cases of corticobasal degeneration (1–6, 12). Accordingly, the autopsy of our patient showed gliosis and achromatic swollen cells in the claustrum bilaterally but the thalamus, putamen, and pallidum were unremarkable. The normal signal intensity of the basal ganglia on MR images of this patient (Fig 1B) reflects this histologic result. The claustrum is a thin structure that is often difficult to see on MR images and sometimes shows slightly high signal intensity on proton density–weighted images, even in healthy volunteers, so it was not surprising that the MR appearance in our case was unremarkable.

The MR appearance of the midbrain was normal in all three of our patients despite the fact that degenerative changes were noted histologically in the substantia nigra of the patient who underwent autopsy. There were numerous melanin-containing macrophages in the substantia nigra, presumably caused by phagocytosis of

melanin-containing cells. The persistence of this melanin, albeit within phagocytic vesicles, may explain the persistent T2 shortening despite the degeneration in this region.

Various histologic findings are seen in the subcortical nuclei in connection with corticobasal degeneration, progressive supranuclear palsy, progressive subcortical gliosis, and Pick disease. Gibb et al (2) noted that, unlike with Pick disease, in corticobasal degeneration, the putamen is slightly more affected than the caudate nucleus and the lateral thalamus shows selective gliosis whereas the medial thalamus is normal. Overall, corticobasal degeneration can be definitively separated from these other disorders by detailed clinicopathologic and radiologic analyses of a large number of cases.

To summarize, we have reported the clinical and MR manifestations of three patients with corticobasal degeneration, including histopathologic results in one. The findings of asymmetric paracentral cortical and basal ganglia atrophy with curvilinear T2 prolongation in the posterolateral putamen may be helpful in ruling out other neurodegenerative disorders, such as progressive supranuclear palsy, progressive subcortical gliosis, and Pick disease. Detailed clinical and neuroradiologic evaluation are necessary to establish the correct diagnosis.

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