

Severe cognitive Disorders after Bilateral Infarction in the Cerebellum

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The role of the cerebellum in cognitive function has been under debate. Anatomical, physiological, and functional neuro-imaging studies suggest that the cerebellum participates in the organization of higher function, but there are few descriptions of clinically relevant cases that address this possibility [1]. Experimental studies have demonstrated that in normal subjects, the cerebellum is activated in cognitive processing tasks, and that different areas of the brain are activated in motor tasks. Neuronal activity within basal ganglia and cerebellar loops with motor areas of the cerebral cortex is highly correlated with parameters of movement, while neuronal activity within basal ganglia and cerebellar loops with areas of prefrontal cortex is related more to aspects of cognitive function [2]. In our study, impairment in executive functions and visuospatial abilities was found in 15 cases of cerebellar stroke, compared to 15 control patients [3]. Cognitive deficits were also revealed in patients with different degenerative cerebellar conditions [4].

PATIENT DESCRIPTION

A 50 year old woman, who was born in India but had been living in Israel for many years, with no previously known brain lesions, was admitted to the hospital complaining of headache, vertigo, general

weakness, and instability during weight bearing. In the computerized axial tomography scan, she had simultaneous infarction in both hemispheres of the cerebellum with no other brain lesions [Figure 1A].

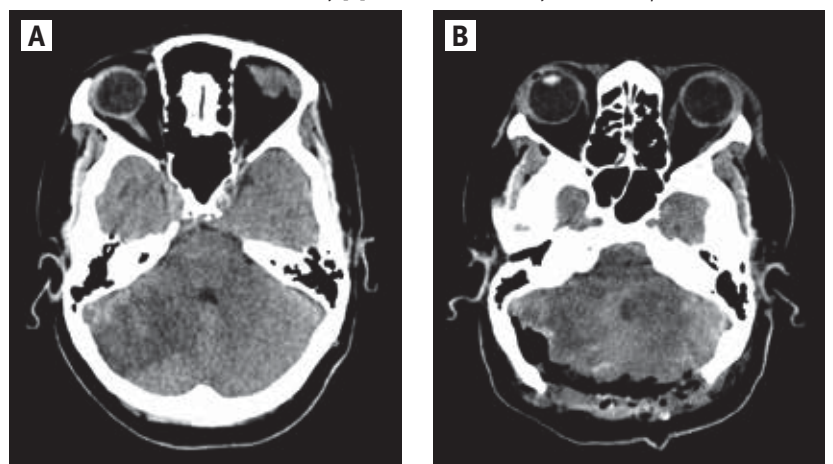
She was hospitalized in the department of neurosurgery and treated by craniotomy and decompression of the posterior fossa [Figure 1B]. During 2 months of in-hospital rehabilitation post-surgery, tests performed by occupational therapists uncovered an array of cognitive disorders. The Cognitive Status Examination (Cognistat) assessment found mild impairment in orientation at time and place, orders comprehension, verbal short-term memory, and problem solving. The screening found moderate impairment in attention, short-term memory, calculation, abstract reasoning, and visual-motor organization. The Rivermead Behavioral Memory Test (1st version translated to Hebrew, 1991) revealed severe impairment in short-term functional

memory and in immediate and short-term verbal memory, and moderate impairment in short-term visual memory. The speech therapist found hypophonic voice, inability to carry out complicated orders, and inability to execute phonemic analysis.

COMMENT

We evaluated the cognitive functioning of a woman with acute lesions in both cerebellar hemispheres during 2 months of rehabilitation. Her neuro-behavioral deficits occurred in concomitance with the cerebellar motor syndrome. Schmahmann and Sherman [1] maintained that behavioral changes were clinically prominent in patients with lesions involving the posterior lobe of the cerebellum and the vermis. They described the cognitive disorders of a 62 year old man after bilateral cerebellar stroke, some of which we found in our patient. These difficulties included impair-

Figure 1. Computerized axial tomography brain scan of a 50 year old woman [A] Bilateral cerebellar infarction before craniotomy [B] and after craniotomy and decompression



ment in the visuospatial skills, verbal short-term memory capacity, abstract reasoning and complex problem solving. Hokkanen et al. [4] examined 26 patients with exclusive cerebellar lesions and found that patients with left cerebellar lesions were slow in a visuospatial task, whereas those with right cerebellar lesions had verbal memory difficulty. These cognitive problems are similar to those of our patient, who has right and left cerebellar hemispheric lesions.

According to Schmahmann and Caplan [5] neuro-behavioral problems are characterized by impairment of executive functions, spatial cognition, and linguistic processing when lesions involve the hemispheric regions of the cerebellar posterior lobes.

There is increasing recognition that the cerebellum contributes to cognitive processing and emotional control in addition to its role in motor coordination.

Anatomical and physiological studies reveal that cerebral association areas sub-serve higher order behavior and are linked preferentially with the lateral hemispheres of the cerebellar posterior lobe, in feed-forward loops via the nuclei of the basis pons, and in feedback loops from deep cerebellar nuclei via the thalamus. There are also reciprocal connections between the cerebellum and hypothalamus. These pathways facilitate cerebellar incorporation into the distributed neural circuits governing intellect, emotion and autonomic function in addition to sensory-motor control [5].

CONCLUSIONS

The pattern of deficit observed in bilateral infarcts highlights the non-motor functions of the cerebellum. This observation has clinical relevance for patients with cerebellar lesions with impairments in reasoning,

problems solving, short-term memory, visual-spatial organization, and linguistic processing.

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References

- Schmahmann JD, Sherman JC. The cerebellar cognitive affective syndrome. *Brain* 1998; 121: 561-79.
- Middleton FA, Strick PL. Basal ganglia and cerebellar loops: motor and cognitive circuits. *Brain Res Brain Res Rev* 2000; 31: 236-50.
- Neau JP, Arroyo-Anllo E, Bonnaud V, Ingrand P, Gil R. Neuropsychological disturbances in cerebellar infarcts. *Acta Neurol Scand* 2000; 102: 363-70.
- Hokkanen LSK, Kauranen V, Roine RO, Salonen O, Kotila M. Subtle cognitive deficits after cerebellar infarcts. *Europ J Neurol* 2006; 13: 161-70.
- Schmahmann JD, Caplan D. Cognition, emotion and the cerebellum. *Brain* 2006; 129: 290-2.

Capsule

Intermittent brain stimulation

Electrical stimulation of the brain to improve its function has been much debated. In an experimental test of working memory, Liu et al. showed that intermittent stimulation of the nucleus basalis in the forebrain of young adult Rhesus macaques improved their memory by up to five times. In contrast, continuous stimulation of the same region impaired memory. Improved memory depended on the neurotransmitter acetylcholine, given that the effect was blocked by antagonists

of cholinergic receptors. The drug donepezil, which blocks cholinesterase's ability to degrade acetylcholine, restored memory performance in animals that received continual stimulation. Intermittent deep brain stimulation could boost the effects of acetylcholine on neurons and/or increase blood flow to the brain to improve memory.

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Eitan Israeli

Capsule

Lighting the way to cell death

Early insights into how the brain controls behavior came from surgical ablation of neural tissue. More recent optogenetic techniques allow higher precision but induce other cellular damage. Smart and colleagues used light to activate a natural cell death pathway. Based on an understanding that caspase-3, a key protein in apoptotic cell death is activated by releasing tension in a linker sequence, the authors inserted a domain into the linker that expands when it is illuminated.

With optimized placement of this LOV2 domain, they built a light-activated caspase-3, "Caspase-LOV." Neural degeneration can be monitored in flies engineered to express Caspase-LOV in retinal, sensory, and motor neurons. The tool has potential in applications that require specific temporal and spatial ablation of cells.

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"A word as to the education of the heart. We don't believe that this can be imparted through books; it can only be imparted through the loving touch of the teacher"

Cesar Chavez, (1927-1993), American civil rights leaders, farm worker, labor leader