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Right Unilateral Agraphia following Callosal Infarction in a Left-Hander

Key Words

Callosal disconnection syndrome
Callosal infarction
Right unilateral agraphia
Left-hander

Abstract

A left-handed Japanese man is reported who presented right-hand agraphia and tactile anomia following callosal infarction. Magnetic resonance imaging revealed an ischemic lesion extending from the posterior half of the trunk to the splenium of the corpus callosum. In his right handwriting, the 'Kana' (phonogram) was more severely impaired than the 'Kanji' (ideogram), and the most frequent typewriting error was morphological followed by neographism. His visuoconstructional ability was also more impaired in the right hand than in the left. Right-hand agraphia in our case is readily explained by the right hemisphere dominance both for language and visuoconstructional ability.

Introduction

Callosal disconnection syndromes, such as agraphia, apraxia or tactile anomia, occur in the left hand in most right-handers, because language and limb praxis are generally represented on the left hemisphere. There have been many case reports of callosal disconnection syndromes in right-handers, but only a few cases of right-hand agraphia in left-handers have been reported following callosal lesion [1-3].

We report on a left-handed patient with agraphia and tactile anomia of the right hand following callosal infarction.

Case Report

This patient is a 52-year-old man with a history of diabetes mellitus of 14 years. He wrote and used chopsticks with his right hand but performed most other activities with his left hand: cutting, throwing,

using a toothbrush, hammer, razor. He was left-handed, but writing and using chopsticks were switched to the right hand while he was in school. One of his sisters was left-handed but all other relatives were right-handed. He graduated at junior high school.

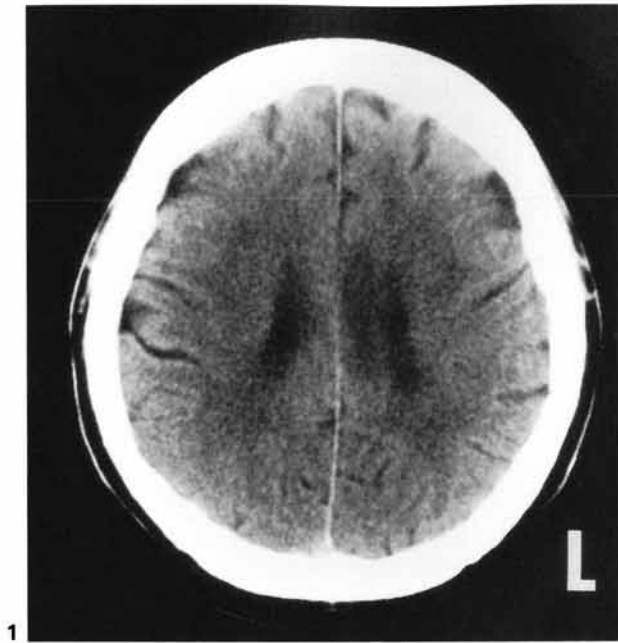
He had been admitted to the department of diabetes in our hospital to control insulin dosage. On February 27, 1991, he experienced sudden drowsiness and weakness in his right lower limb. These symptoms gradually resolved in 3 days but after that, he could not write with his right hand. He was transferred to our department on March 28.

General physical examination revealed mild hypertension. On neurological examination, visual acuity was decreased because of diabetic retinopathy (visus dextra = 0.1, visus sinistra = 0.1). Bilateral sensorineuronal hearing loss was detected because of a history of excessive exposure to loud noise (falling audiogram, 1,000 Hz 30 dB, 8,000 Hz 70 dB). There was no weakness but sensory examination revealed some deficits in all extremities at the distal portion in touch, pain, temperature and vibration but tactile extinction was not detected. Deep tendon reflexes were decreased in all four extremities. No pathological reflex was elicited. Except for diabetes mellitus, no abnormal findings were found in routine laboratory tests. Cranial CT revealed a low-density area in the corpus callosum, extending from the trunk to the splenium, involving mainly its left side (fig. 1). In

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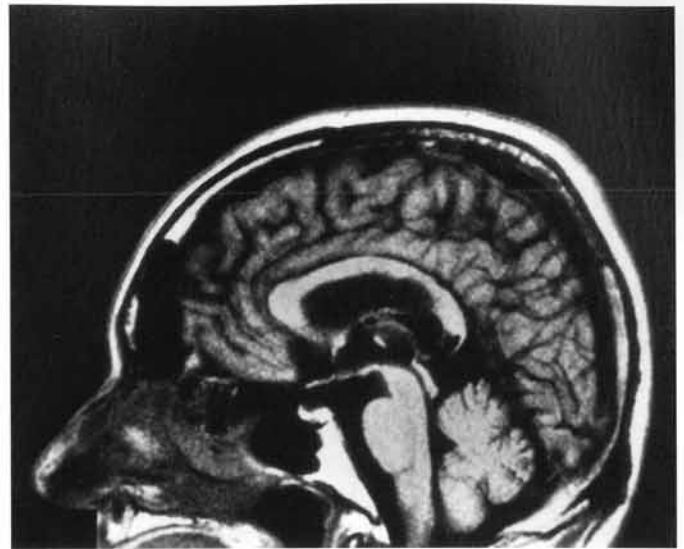


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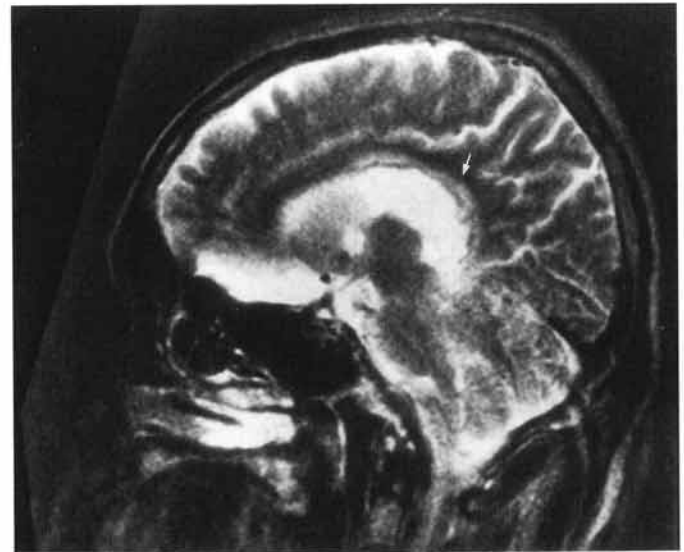
Fig. 1. Cranial CT revealed a low-density area in the corpus callosum, extending from the trunk to the splenium, mainly involving its left side.

Fig. 2. T₁-weighted magnetic resonance imaging (TR400, TE21) of the midline sagittal section, low-intensity area was demonstrated in the lower portion of the splenium.

Fig. 3. T₂-weighted imaging (TR2500, TE100) of the sagittal section 5 mm left of the midline, linear high-intensity area was demonstrated in the posterior part of the trunk (arrow).



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T₁-weighted magnetic resonance imaging of the midline sagittal section, a low-intensity area was demonstrated in the lower portion of the splenium (fig. 2) and in T₂-weighted imaging of the sagittal section 5 mm left of the midline, a linear high-intensity area was demonstrated in the posterior part of the trunk (fig. 3).

Detailed neuropsychological examinations were performed from March 28 to April 20, 1991.

He was attentive, cooperative and well orientated to time, place and person. The digit span was 8 forward and 4 backward. He was able to recall 3 objects after a 3-min distraction and had an intact remote memory. His calculation was slightly disturbed but right-left discrimination and finger gnosis were intact. He had normal spontaneous speech without any paraphasia. Comprehension, naming, repetition and reading were intact. In contrast, his writing ability was disturbed (later, we will describe the details). Constructional ability was disturbed for either hand. Copying a cube or a cross was awk-

ward (fig. 4), and Kohs' block design test performed separately with his right and left hand was 38 and 50 IQ, respectively. Praxis to verbal command or imitation and object handling were well done with both hands, and no buccofacial dyspraxia was detected. His WAIS score was as follows: verbal IQ = 83, performance IQ = 51, full scale IQ = 65.

The writing performance with his right and left hand was clearly dissociated. In spontaneous writing and writing to dictation, he was able to write correctly with his left hand but not with his right hand. He was asked to write 76 Kanji (ideogram) and its corresponding Kana (phonogram) which had been learned in the 1st year of primary education (fig. 5). In his left hand, there was a little clumsiness or distortion but Kana letters were written correctly (100% correct response) and Kanji almost well (89% correct response). In contrast, his right handwriting was disturbed in both Kana and Kanji, especially in the former (17 and 29% correct response, respectively, $p <$

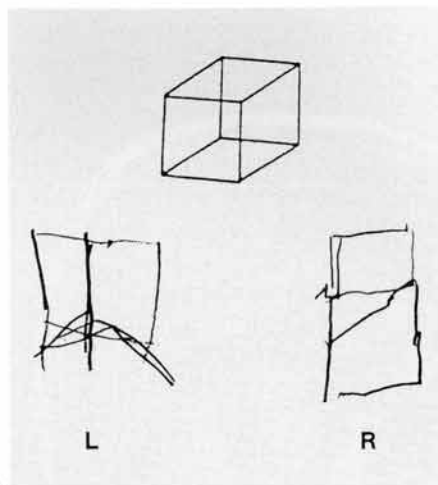


Fig. 4. Copying a cube was awkward in either hand.

Fig. 5. Writing to dictation with the left and right hand. In his left hand, there was a little clumsiness or distortions but Kanji and Kana were written correctly, but his right handwriting was disturbed in both Kana and Kanji, especially in the former.

Task		Pronunciation Meaning	Left hand		Right hand	
Kanji	Kana		Kanji	Kana	Kanji	Kana
天	てん	[ten] sky	天	てん	他	カ
本	ほん	[hon] book	本	ほん	本	ざひ
金	きん	[kin] gold	金	きん	他	きん
犬	いぬ	[inu] dog	犬	いぬ	犬	た犬
赤	あか	[aka] red	赤	あか	赤	あか

0.05). The writing errors were categorized into 7 types according to the method of Ohigashi et al. [4]: (1) morphological error in which a portion of the required character was written but distorted by partial substitution or additional strokes; (2) phonological error in which an incorrect but complete character phonologically related to the required one was written; (3) semantic error in which an incorrect but complete character semantically related to the required one was written; (4) perseveration; (5) neographism in which it was not possible to identify an existing character in the writing system; (6) mirror writing; (7) unclassified. Kanji errors were morphological error in 48%, neographism in 26%, perseveration in 17%. Kana errors were morphological error in 30%, neographism in 17%, perseveration in 13% and unclassified in 17%. There was no 'scrawl' in both Kanji and Kana writings. Phonological error, semantic error or mirror writing was rare in both Kana and Kanji. All but 1 errors of Kanji in the left hand were morphological errors. Even when copy-writing with his right hand, the correct response was only 50% of Kanji and 45% of Kana. Six months later, we reexamined him. There was no improvement in his right handwriting at all.

Objects were placed in the patient's either hand with his eyes closed. He could easily name the objects in his left hand, but could not name them in his right hand or manipulate them. But he could choose the object among 4 objects presented in the right hand. This phenomenon gradually resolved, and 6 months later, he could correctly name the objects in his right hand.

Pseudoneglect [5] was observed in the right hand but not in the left hand. Other callosal disconnection syndromes such as diognostic dyspraxia, alien hand syndrome or intermanual conflict were not observed.

Discussion

This left-handed man showed right-hand agraphia and tactile anomia following callosal infarction. While many cases of left-hand agraphia by callosal injury in right-handers have been reported, there are only a few cases of right-hand agraphia in left-handers. To our knowledge, only 3 cases have been reported of right-hand agraphia without aphasia that could be explained by callosal disconnection. Dejerine and Thomas [1] and Nielsen [2] reported cases of right-hand agraphia who were left-handed except for writing. In the former, postmortem study revealed a massive infarction involving the right hemisphere and the right side of the corpus callosum. In the latter, the lesion was not clear, but the clinical features implied lesions involving the anterior cerebral artery distribution and the anterior four fifths of the corpus callosum [6]. Rosa et al. [3] recently reported on a case of right-hand agraphia following Marchiafava-Bignami disease in a left-hander. Cranial magnetic resonance imaging showed lesions extending from the genu to the splenium and hemispheric white substance of the frontal horns. Therefore, this is the 2nd case of radiologically proven right-hand agraphia in the left-hander by callosal lesion and the first of such cases by cerebral infarction.

In most right-handers, language and limb praxis are generally represented on the left hemisphere, while in left-handers, a relative bilaterality of representation for these functions has been suggested. Hécaen et al. [7] investigated higher cortical functions in 73 left-handed subjects with right or left unilateral lesion. They concluded that a relative bilaterality of representation for language and cognitive functions is a typical feature of the cerebral organization found in certain left-handed subjects who seem to belong essentially to the so-called familial group, and a rapid regression of functional defects usually occurs in left-handers. In this case, right-hand tactile anomia gradually resolved, so it is suggested that the left hemisphere had retained some language ability. However, Iwata [8] suggested that left-right somatosensory information is transferred through a considerably broad part of the corpus callosum. Improvement of tactile naming in this case may be a result of the intact part of the corpus callosum. It is impossible to clearly define the language dominance in this case because neither a dichotic listening test nor sodium amytal studies were performed, but a quite strong language dominance in the right hemisphere was suggested by the fact that his right agraphia had not improved at all at the 6-month follow-up examination.

Since there was no ideomotor apraxia or 'scrawl', right-hand agraphia in this case is not readily classified into apraxic agraphia [9]. However, our case had difficulty in copying a cube or letters, and the most frequent writing error was morphological followed by neographism, so we cannot deny a constructional factor in his writing. Aphasie agraphia [10] which consists of paraphasia or partial paraphasia without disturbance in copying letters is inappropriate to this case. Yamadori et al. [11] reported a case of left unilateral agraphia and tactile anomia, and they described the agraphia as 'disconnection agraphia' to emphasize the dissociative nature of the disturbance. Ohigashi et al. [4] reported a case of left unilateral agraphia, agreeing with Yamadori's [11] description. The writing characters of our case resembled these cases.

The written Japanese language is unusual having 2 distinct sets of written characters, i.e., the Kanji (ideogram) and the Kana (phonogram). It has been reported that the 2 writing systems in Japanese can be selectively impaired [12, 13]. In other words, the different pathways can be used for the writing of Kanji and Kana. The writing performance in our case was more severely impaired in Kana than in Kanji. Yamadori et al. [11] and Tanaka et al. [14] described the same tendency. Yamadori et al. [11, 15] assumed that although the Kanji and Kana letters are represented on both hemispheres as an element of linguis-

tic expression, the hemisphere nondominant for language lacks the capacity to organize graphemes into a correct meaningful sequence, and that the Kanji can be mediated by the meaning directly from its graphical character while the Kana presupposes phonetic control which is not available in the hemisphere nondominant for language. In our case, it is speculated that the left hemisphere was nondominant for language, so the right-hand performance was worse in Kana than in Kanji.

The visuoconstructional ability performed separately with both hands using Kohs' block design test was more impaired with the right hand than the left. LeDoux et al. [16] tested the block design performance of a patient with complete surgical section of the corpus callosum. Under conditions of free visual field block design presentation, the performance was clearly better with the left hand than the right. Loring et al. [17] examined a patient who had undergone complete corpus callosotomy employing free-field stimuli. The performance of visual spatial tasks was superior in the left hand, while the verbal tasks were superior in the right hand. These results suggest that specialized functions of the cerebral hemispheres may be observed for response output in the absence of restricted hemisphere input. So, in our patient, it is speculated that the left hemisphere was also nondominant for the visuospatial ability. However, the copying example showed almost identical impairments for both hands and the left-right difference of Kohs' block design test was weaker than in the above-mentioned patients. It might imply that the hemispheric dominance of the visuospatial ability in our patient was not so strong.

Right-hand agraphia in our case can be explained by left hemisphere nondominance both for language and visuoconstructional ability.

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