

Right Hand Predominant Constructional Apraxia due to Right Hemisphere Infarction without Corpus Callosum Lesions

Zen Kobayashi¹, Mayumi Watanabe², Yuri Karibe², Chika Nakazawa²,
Yoshiyuki Numasawa³, Hiroyuki Tomimitsu¹ and Shuzo Shintani^{1,2}

Abstract

A 74-year-old right-handed woman without cognitive impairment suddenly developed nonfluent aphasia. Brain MRI showed acute infarction in the right frontal lobe and insula without involvement of the corpus callosum. A neurological examination demonstrated not only transcortical motor aphasia, but also ideomotor apraxia and right hand predominant constructional apraxia (CA). To date, right hand predominant CA has only been reported in patients with corpus callosum lesions. The right hand predominant CA observed in our patient may be associated with the failure to transfer information on the spatial structure from the right hemisphere to the motor cortex of the left hemisphere.

Key words: constructional apraxia, right hemisphere, corpus callosum, commissural fibers

(Intern Med 53: 1553-1558, 2014)

(DOI: 10.2169/internalmedicine.53.2081)

Introduction

Constructional apraxia (CA) refers to the inability of patients to accurately copy a drawing or three-dimensional construction (1). This condition can be caused by either the failure to effectively analyze the spatial structure of a model (perceptual function) or coordinate motor output to reproduce the structure through a sequence of actions (motor function) (2). Whether the former or latter is related to the failure in reproducing visual figures is usually unclear in each patient in clinical practice; therefore, the more general term “constructional disability” is also used to describe this condition. Constructional praxis is thought to be closely associated with the parietal and prefrontal cortex functions (2).

To date, right hand predominant CA has only been reported in patients with corpus callosum lesions (3-6). This fact can be explained by the failure to transfer information from the right hemisphere, which is considered the dominant hemisphere for constructional praxis, to the motor regions of the left hemisphere (3). We herein report a patient

with right hemisphere infarction in whom CA was predominant in the right hand even though the corpus callosum was not involved.

Case Report

A 74-year-old right-handed woman suddenly developed nonfluent aphasia and consulted our hospital with her daughter on the same day. The patient was right-handed and had no history of correction of handedness. She preferred the right hand for all manual activities, including writing. Her past medical history included myocardial infarction (at age 69), hypertension, dyslipidemia and bronchial asthma, although no brain diseases were reported, including cognitive impairment. There was no familial history of left-handedness or ambidexterity. The patient had been treated at the Department of Cardiology and Respiratory Illnesses at our hospital and had been taking aspirin, losartan and pravastatin. There was no history of smoking or alcohol consumption.

A neurological examination performed on admission dem-

¹Department of Neurology, JA Toride Medical Center, Japan, ²Department of Rehabilitation, JA Toride Medical Center, Japan and ³Department of Neurology and Neurological Science, Tokyo Medical and Dental University, Japan

Received for publication November 7, 2013; Accepted for publication January 13, 2014

Correspondence to Dr. Zen Kobayashi, zen@bg7.so-net.ne.jp

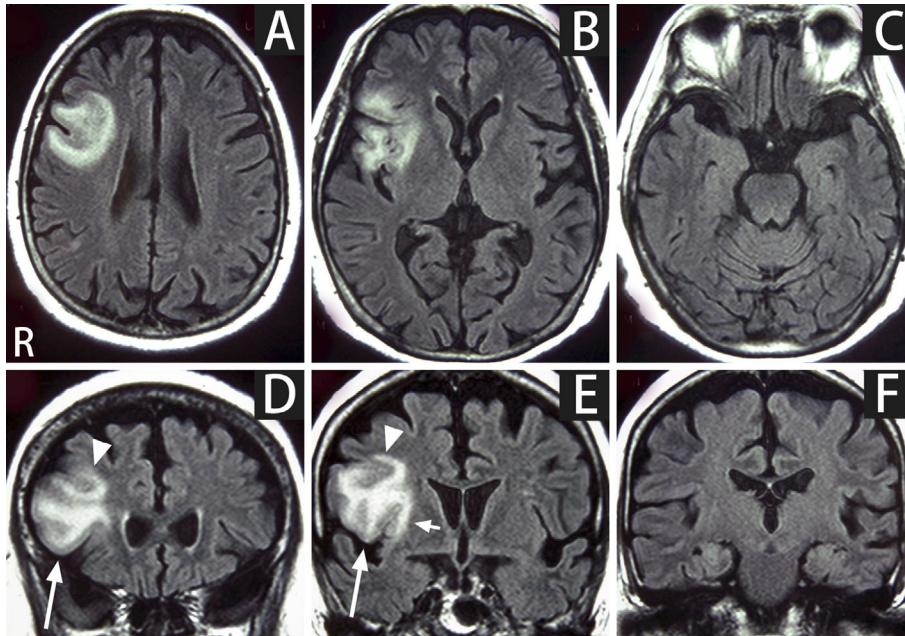


Figure 1. A-C: Fluid attenuated inversion recovery (FLAIR) MRI (axial, TR: 9,000 ms, TE: 106 ms) demonstrated a high-intensity lesion in the right frontal lobe and anterior portion of the right insula (A, B), with no enlargement of the inferior horn of the lateral ventricles (C). D-F: Coronal images showed a lesion involving the middle and posterior portion of the right inferior (D, E, large arrows) and middle frontal (D, E, arrowheads) gyri and the anterior portion of the right insula (E, small arrow). There were no corpus callosum lesions (D-F) or enlargement in the inferior horn of the lateral ventricles (F).

onstrated motor aphasia. The National Institute of Health (NIH) stroke scale score was 2; the patient was unable to identify the current month (1 point) and exhibited moderate aphasia (1 point). There was no motor weakness, ataxia, sensory disturbance, hemi-inattention or extinction. The results of a blood test were normal, except for a D-dimer level of 3.15 $\mu\text{g/mL}$ (normal range: <1.0). An electrocardiogram (ECG) showed a normal sinus rhythm without abnormal Q waves.

Diffusion-weighted brain MRI showed acute infarction in the middle and posterior portions of the right inferior and middle frontal gyri and the anterior portion of the right insula. No corpus callosum lesions or enlargement of the inferior horn of the lateral ventricles were detected (Fig. 1 shows MRI conducted seven days after onset). Based on the criteria described by Mariën et al. (7), the patient was diagnosed as having crossed aphasia. There was neither significant stenosis nor occlusion in the internal carotid or middle cerebral arteries on brain MRA or carotid ultrasonography. A transthoracic echocardiogram demonstrated a reduced wall motion and thinning of the apex, consistent with the findings of an old myocardial infarct. There were no apparent intracardiac thrombi, and Holter ECG detected no paroxysmal atrial fibrillation. The trial of org 10172 in acute stroke treatment (TOAST) classification of the ischemic stroke subtype was “stroke of undetermined etiology.”

$^{99\text{m}}\text{Tc}$ -ethylcysteinate ($^{99\text{m}}\text{TcECD}$)-SPECT conducted seven days after onset demonstrated hypoperfusion in the area of

infarction without involvement of the parietal lobes (Fig. 2A). Regional cerebral blood flow (CBF) was compared with the age-matched database of easy Z-score Imaging System (eZIS, version 3.5.2 FUJIFILM RI Pharma, Tokyo, Japan) (8, 9). Images of eZIS demonstrated regions showing a Z-score of 2 or more in the region of infarction without involvement of the parietal lobes (Fig. 2B).

The patient’s neuropsychological function was evaluated within three weeks after onset. Table 1 shows the results of the Standard Language Test of Aphasia (SLTA) (10-12), a standardized Japanese test for aphasia. While object naming and word fluency were severely impaired, auditory comprehension and word/sentence repetition were relatively preserved. The SLTA also revealed agraphia and impairment of calculation. The findings of SLTA were largely consistent with a diagnosis of transcortical motor aphasia.

The patient’s apraxia was evaluated using the Standard Performance Test for Apraxia (SPTA) (13), a standardized Japanese test for apraxia (Table 2). There was no motor or comprehension impairment disturbing the evaluation of apraxia. The patient was unable to cough on verbal command or perform imitation, indicating the presence of buccofacial apraxia. Meaningless gestures were mildly disturbed in the bilateral upper limbs to an equal extent. The patient’s ability to perform fox imitation (14) was almost normal bilaterally; however, pigeon imitation (14) was impossible. While gestures of tool use were mildly impaired in the bilateral upper limbs to an equal extent, actual tool use was not

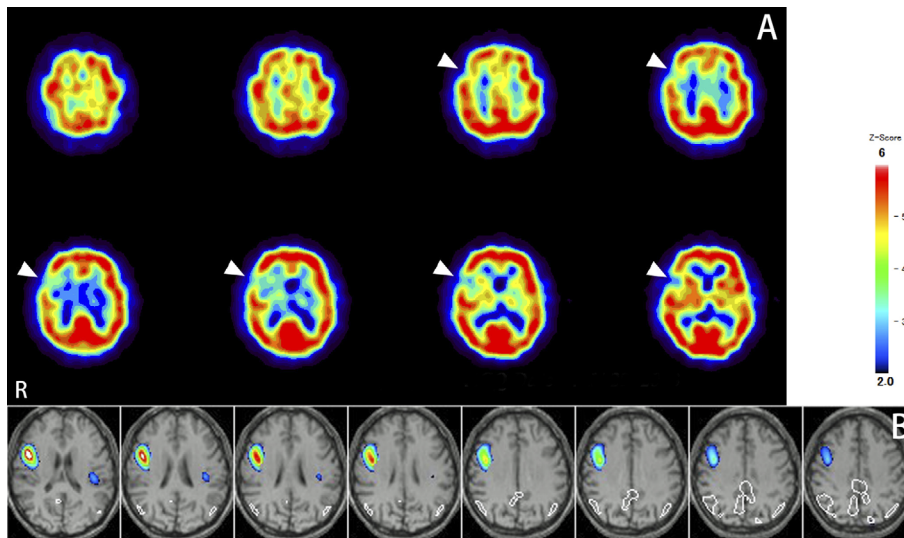


Figure 2. A: $^{99m}\text{TcECD}$ -SPECT demonstrated hypoperfusion in the area of infarction (arrowheads) without apparent involvement of the parietal lobes. B: Images of eZIS revealed regions showing a Z-score of 2 or more in the region of infarction without involvement of the parietal lobes.

Table 1. Results of the Standard Language Test of Aphasia (SLTA)

		Score/Maximum
Auditory comprehension	Auditory word recognition	10/10
	Sentence comprehension	8/10
	Follow verbal commands	4/10
	Kana letter discrimination	9/10
Speaking	Object naming	13/20
	Word repetition	10/10
	Describe behaviors	7/10
	Explain picture story	3/6
	Sentence repetition	3/5
	Word fluency	2/15
	Read aloud kanji words	5/5
	Read aloud kana letters	10/10
Reading comprehension	Read aloud kana words	5/5
	Read aloud short sentences	5/5
	Kanji word-picture matching	10/10
	Kana word-picture matching	10/10
	Sentence-picture matching	9/10
Writing	Follow written commands	5/10
	Write kanji words	4/5
	Write kana words	1/5
	Narrative writing	3/6
	Dictate kana letters	10/10
	Dictate kanji words	4/5
	Dictate kana words	3/5
Dictate short sentences	1/5	
Calculation		12/20

disturbed. These findings were considered to reflect ideomotor apraxia. The patient was able to transfer meaningless gestures from the left to right hand (and vice versa) with closed eyes, a skill that is frequently impaired in patients with corpus callosum lesions (15).

In order to evaluate CA, the patient was asked to copy figures, first with the right hand and then with the left hand. On the two-dimensional drawing made with the right hand, asymmetry of the figures was observed, although the patient's figure copying ability with the left hand was almost symmetric (Fig. 3A-C). On the three-dimensional drawing made with the right hand, disorganization of the cube was apparent, while deformation was mild on the cube image copied with the left hand (Fig. 3D-F). The results of the drawing tasks of the SPTA did not suggest the presence of hemispatial neglect. The building block test, a block design test on the Wechsler Adult Intelligence Scale (WAIS), was performed first with the right hand and then with the left hand. The time to completion was 126 seconds (normal range: <60) with the right hand and 30 seconds with the left hand. The second trial was also performed first with the right hand followed by the left hand immediately after the first trial. The time to completion was 240 and 28 seconds, respectively. Because the time to completion of the right hand in the second trial was much longer than that of the left hand in the first trial, the presence of CA in the right hand was strongly suggested.

Although the various types of apraxia were observed in this patient, as described above, activities of daily living were not impaired by apraxia during hospitalization for approximately three weeks. The line bisection and line cancellation tasks on the Behavioral Inattention Test (BIT) did not reveal hemispatial neglect. The Wechsler Memory Scale-Revised scores were as follows: verbal memory index: 82, visual memory index: 89, general memory index: 83 and attention/concentration index: 79. Decreased verbal and general memory indexes may be influenced by aphasia.

Table 2. Results of the Standard Performance Test for Apraxia (SPTA)

Type of command		Number of error items		Number of total items
		Severe errors	Mild errors	
Face, habitual gesture	Verbal commands	1	0	3
	Imitation	1	0	3
Face, gesture of tool use	Verbal commands	0	0	1
	Imitation	NE	NE	1
Face, actual tool use	Verbal commands	NE	NE	1
	Imitation	NE	NE	1
Upper limb, habitual gesture	Right hand, verbal commands	0	0	3
	Right hand, imitation	0	0	3
	Left hand, verbal commands	0	0	3
	Left hand, imitation	0	1	3
Upper limb, meaningless gesture	Right hand, imitation	0	2	2
	Left hand, imitation	0	2	2
	From left to right, transfer	0	0	1
	From right to left, transfer	0	0	1
Both hands, meaningless gesture	Imitation	1	2	3
Upper limb, sequential meaningless gesture	Right hand, imitation	1	0	1
	Left hand, imitation	1	0	1
Upper limb, dressing	Verbal commands	0	0	1
	Imitation	NE	NE	1
Upper limb, gesture of tool use	Right hand, action commands	0	2	4
	Left hand, action commands	0	2	4
	Right hand, imitation	0	1	4
	Left hand, imitation	0	1	4
Upper limb, actual tool use	Right hand, use commands	0	0	4
	Left hand, use commands	0	0	4
	Right hand, action commands	NE	NE	4
	Left hand, action commands	NE	NE	4
	Right hand, imitation	NE	NE	4
	Left hand, imitation	NE	NE	4
Upper limb, sequential habitual gesture	Verbal commands	0	0	2
Lower limb, gesture of tool use	Right lower limb	0	0	1
	Left lower limb	0	0	1
Lower limb, actual tool use	Right lower limb	NE	NE	1
	Left lower limb	NE	NE	1
Figure drawing (without model)	Right hand	0	2	2
	Left hand	0	0	2
Figure drawing (copying)	Right hand	1	1	2
	Left hand	0	1	2
Building block test	Right hand	1	0	1
	Left hand	0	0	1

NE: not examined

Discussion

Although ideomotor apraxia and dyscalculia are rare in patients with right hemisphere lesions, a previous study of patients with crossed aphasia demonstrated that these features were present in a proportion of subjects (7). This study also showed that constructional apraxia was not uncommon (27/41 cases) in patients with crossed aphasia (7). This find-

ing indicates that critical regions for constructional praxis are usually present in the right hemisphere in both uncrossed and crossed aphasia patients.

In the present patient, while ideomotor apraxia was observed in the bilateral upper limbs to an equal extent, CA was more severe in the right hand than in the left. Unlike the right hand, the spatial disorganization of figure copying with the left hand was mild, and the result of the building block test with the left hand was normal. Accordingly, the

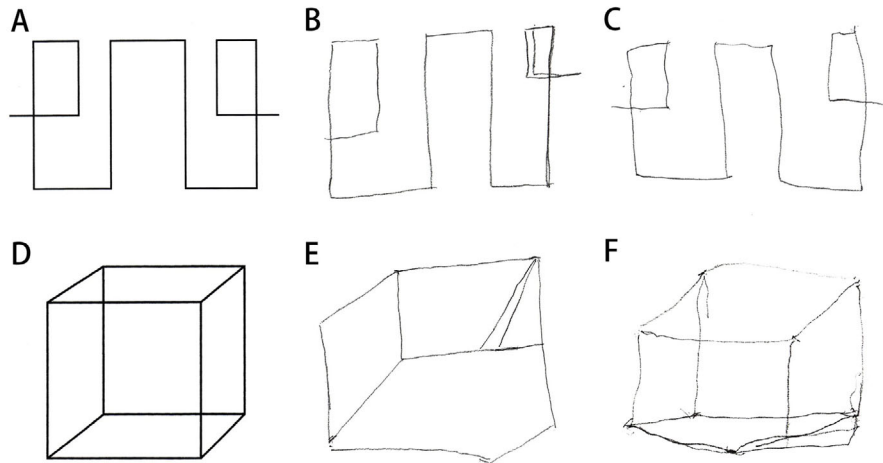


Figure 3. A-C: When the figure shown in (A) was reproduced with the right hand, asymmetry was observed (B). In contrast, the figure copied with the left hand was almost symmetric (C). D-F: When the cube shown in (D) was reproduced with the right hand, disorganization was apparent (E). Meanwhile, deformation was mild in the image of the cube copied with the left hand (F).

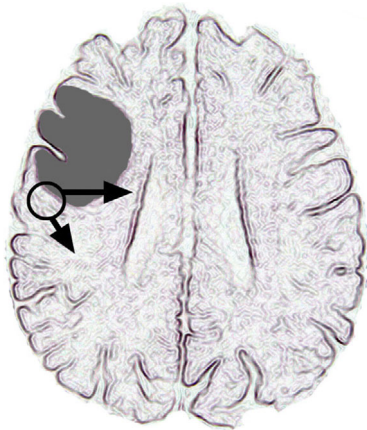


Figure 4. This schematic figure may explain the right hand predominant constructional apraxia (CA) observed in our patient. The dark gray area indicates the infarct. We assume the black circle to be one of the critical regions for constructional praxis. The long arrow indicates fibers passing from this region to the motor cortex of the left hemisphere, whereas the short arrow shows fibers passing to the motor cortex of the right hemisphere. The right hand predominant CA may be explained by the preferential involvement of fibers passing to the motor cortex of the left hemisphere.

ability to analyze the spatial structure of the model was considered to be largely preserved in this patient, whereas the transfer of information from the right hemisphere to the motor cortex of the left hemisphere appeared to be impaired, similar to that noted in patients with corpus callosum lesions (3-6).

To date, right hand predominant CA has only been reported in patients with corpus callosum lesions (3-6). However, if the commissural fibers carrying information on the spatial structure are involved in the right hemisphere before passing through the corpus callosum, right hand predomi-

nant CA may occur theoretically, even though the corpus callosum itself is not affected. Fig. 4 shows a schematic drawing that may explain the right hand predominant CA observed in our patient. We assume the black circle in this figure to be one of the critical regions for constructional praxis. The right hand predominant CA may be explained by the preferential involvement of the fibers passing from this region to the motor cortex of the left hemisphere. Further studies of a larger number of patients are needed to clarify whether right hand predominant CA occurs in association with right hemisphere infarction in patients without corpus callosum lesions.

The authors state that they have no Conflict of Interest (COI).

References

- Russell C, Deidda C, Malhotra P, Crinion JT, Merola S, Husain M. A deficit of spatial remapping in constructional apraxia after right-hemisphere stroke. *Brain* **133**: 1239-1251, 2010.
- Caminiti R, Chafee MV, Battaglia-Mayer A, Averbeck BB, Crowe DA, Georgopoulos AP. Understanding the parietal lobe syndrome from a neurophysiological and evolutionary perspective. *Eur J Neurosci* **31**: 2320-2340, 2010.
- Boldrini P, Zanella R, Cantagallo A, Basaglia N. Partial hemispheric disconnection syndrome of traumatic origin. *Cortex* **28**: 135-143, 1992.
- Marangolo P, De Renzi E, Di Pace E, Ciurli P, Castriota-Skandenberg A. Let not thy left hand know what thy right hand knoweth. The case of a patient with an infarct involving the callosal pathways. *Brain* **121**: 1459-1467, 1998.
- Lausberg H, Göttert R, Münssinger U, Boegner F, Marx P. Callosal disconnection syndrome in a left-handed patient due to infarction of the total length of the corpus callosum. *Neuropsychologia* **37**: 253-265, 1999.
- Iwatsuki K, Murakami T, Manabe Y, et al. Two cases of Japanese CADASIL with corpus callosum lesion. *Tohoku J Exp Med* **195**: 135-140, 2001.
- Mariën P, Paghera B, De Deyn PP, Vignolo LA. Adult crossed

- aphasia in dextrals revisited. *Cortex* **40**: 41-74, 2004.
8. Kanetaka H, Matsuda H, Asada T, et al. Effects of partial volume correction on discrimination between very early Alzheimer's dementia and controls using brain perfusion SPECT. *Eur J Nucl Med Mol Imaging* **31**: 975-980, 2004.
 9. Matsuda H, Mizumura S, Nagao T, et al. Automated discrimination between very early Alzheimer disease and controls using an easy Z-score imaging system for multicenter brain perfusion single-photon emission tomography. *AJNR Am J Neuroradiol* **28**: 731-736, 2007.
 10. Mimura M, Kato M, Kato M, et al. Prospective and retrospective studies of recovery in aphasia. Changes in cerebral blood flow and language functions. *Brain* **121**: 2083-2094, 1998.
 11. Maeda K, Ito T, Ogawa N, Nakajima A, Sanada M, Kawai H. A case of agrammatism due to cerebral infarction of the middle-lower part of the right precentral gyrus. *Rinsho Shinkeigaku (Clinical Neurology)* **49**: 414-418, 2009 (in Japanese, Abstract in English).
 12. Japan Society for higher brain dysfunction. Standard Language Test of Aphasia (SLTA). Shinkoh-Igakushuppansha, Tokyo, 2003.
 13. Japan Society for higher brain dysfunction. Standard Performance Test for Apraxia (SPTA). Shinkoh-Igakushuppansha, Tokyo, 2003.
 14. Yamaguchi H, Maki Y, Yamagami T. Yamaguchi fox-pigeon imitation test: a rapid test for dementia. *Dement Geriatr Cogn Disord* **29**: 254-258, 2010.
 15. Leiguarda R, Starkstein S, Berthier M. Anterior callosal haemorrhage. A partial interhemispheric disconnection syndrome. *Brain* **112**: 1019-1037, 1989.