

still be worse for patients with large aneurysms (RR = 1.34; 95% CI 0.94 to 1.90). We found one other study on aneurysm size and outcome; in that study no relation was found.⁹ Two factors may have introduced a bias toward patients with good outcome in that study. First, the study was performed in a tertiary care center; secondly, aneurysm size was assessed on conventional angiograms, and thus not in patients who are not candidates for operation because of a poor condition. Yet, in that study, patients with large aneurysms had a longer period of unconsciousness after the hemorrhage and patients with small aneurysms had a greater chance of complete recovery. The data of this previous study are therefore in agreement with our data.

In our series, patients with large aneurysms were less frequently operated. This implies that the poor outcome in these patients might partly be explained by an increase in frequency of rehemorrhage, but this was not the case (see table 2). The larger proportion of patients with large aneurysms who have not been operated can be explained by the worse clinical condition from the outset, and is therefore a consequence and not so much a causal factor for the poor outcome.

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Apraxic agraphia due to thalamic infarction

Article abstract—The authors report a patient of pure apraxic agraphia with normal praxis due to left thalamic infarction. ¹⁵O-gas-PET showed reduced oxygen metabolism in the left thalamus and the left dorsolateral premotor area, while MRI and ¹¹C-fulumazenil-PET showed no remarkable lesions in the frontal cortex. The patient's word imaging remained normal. The authors hypothesize that thalamic destruction causes pure apraxic agraphia by exerting a remote effect on left dorsolateral premotor area and blocking somewhere between graphemic area and motor programming. **Key words:** Apraxic agraphia—Left thalamic infarction—Dorsolateral premotor—PET.

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Apraxic agraphia with normal praxis, or pure apraxic agraphia, is a selective impairment of writing characterized by deteriorated orthographic production with otherwise normal praxis, sensory motor functions, and preserved oral spelling and typing.¹

Neuroanatomic investigations of the syndrome have been few. Some reports have implicated lesions in the left parietal lobe,^{1–3} and others the frontal lobe.^{3–5} Most of the reported cases have been accompanied by aphasia, visuospatial defects, or apraxia.

Thalamic agraphia has been reported seldomly, and its exact location and pathomechanism are unknown.^{6,7} One study favored the centromedian nucleus, another the anterior portion of the left thalamus, and both suggested the possibility of secondary impairment in the frontal or parietal cortex by a remote effect.

We report a patient presenting with pure apraxic agraphia after an infarction restricted to the left dor-

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somedial thalamic nucleus. Details of the pathomechanism and clinical pattern of his apraxic agraphia are discussed.

Patient presentation. A 78-year-old right-handed man was hospitalized after the sudden onset of a writing disorder. Since graduating from business school, he had worked in an office for more than 50 years. He had cervical spondylosis, which disturbed his walking, but was otherwise healthy. On December 28, 1998, the patient suddenly could not write any characters or numbers and was referred to our hospital. Physical examination results were normal. The neurologic examination showed bilateral hyperreflexia with severe spasticity of the lower extremities due to cervical spondylosis and pure agraphia in both hands. The patient was alert and his hands had no sensory-motor deficits. His verbal IQ was 91, performance IQ 71, and he had a total IQ score of 80 on the Wechsler Adult Intelligence Scale Revised. His score on Raven's Colored Progressive Matrices was 18 of 36. He had no aphasia, alexia, apraxia, neglect, amnesia or constructional disturbance. His scores on Wisconsin card sorting test for 1st and 2nd trial were: total correct 48 of 128, 84 of 128, respectively; category completed 2, 5; perseverative responses 35, 25. MRI showed a left thalamic infarction in dorsomedial nucleus (figure 1). Intensity change and swelling were present in the bilateral splenium but disappeared within a few weeks. The lesion was not enhanced by gadolinium. ¹⁵O-gas-PET showed significant oxygen hypometabolism in the left dorsolateral premotor area as well as the left thalamus (figure 2). His cerebral metabolic rate of oxygen (CMRO2) was significantly low in the left frontal lobe as compared to the control \pm 2SD (2.22 and 3.16 ± 0.36). The blood flow and oxygen metabolism were matched in the left frontal cortex and there were no evidence of ischemia in the left middle cerebral arterial territory. No focal defect was found with ¹¹C-flumazenil-PET (FMZ-PET).

Language evaluation. The Western Aphasia Battery was performed 14 days after onset. The patient's spontaneous speech, auditory comprehension, repetition, naming, reading, praxis, and construction were perfect (10 points all subjects). In contrast, he could not write kanji, kana, the Roman alphabet, or Arabic numerals (0.9 points for writing) with either hand. Scores on other naming tests were also perfect. His scores of kanji, kana, the Roman alphabet, and numbers were as follows: for reading 20 of

20, 40 of 40, 20 of 20, and 10 of 10; for copying 20 of 20, 40 of 40, 20 of 20, and 10 of 10; and for dictation 3 of 20, 4 of 40, 8 of 20, and 4 of 10. When the patient would recognize his errors he would stop writing. The majority of errors involved the partial omission or addition of characters. Scrawling, no reaction, neographism, and complete substitution were not seen. He was able to spell kanji orally and make sentences by pointing at kana in the Japanese syllabary. He could orally describe correctly the orientation of each stroke of a kanji character.

To clarify the mechanism of the patient's agraphia, we devised a special task. Ten kanji of various levels of difficulty were selected, and he was asked to write them while describing the orientation of each stroke of a kanji. His writing, without the oral guide, was compared with the results in A-B-B-A order (A: with the oral guide, B: without it, the scores being 6 of 10, 2 of 10, 2 of 10 and 7 of 10) ($p < 0.01$). Interestingly, the patient found it easier to write with the oral guide.

Discussion. The patient had pure apraxic agraphia caused by tissue hypoactivity of the left frontal cortex secondary to the remote effect of a left thalamic infarction. This frontal area, which had reduced oxygen metabolism in ¹⁵O-gas-PET, showed no lesion in MRI or FMZ-PET; this supports the remote effect hypothesis. Furthermore, the thalamo-cortical connection from the dorsal medial nucleus reaches to the frontal cortex.⁸ Pure agraphia by thalamic destruction, however, has rarely been reported.^{6,7} It may be that when the lesion is extended, thalamic dementia appears and the agraphia cannot be detected, or it may be that when the lesion is small, it can be overlooked.

The lesions of thalamic agraphia are reported to be the centromedian nucleus, parafascicular nucleus, dorsal medial nucleus, or anterior nuclei, all of which belong to either the paramedian thalamic or premammillary artery territories or both.^{6,7} This is compatible with our patient's lesion. The possibility of the secondary effect of thalamic involvement in the frontal or parietal cortex was discussed in these reports, but the patients had complications such as alexia, anomia, or mild consciousness disturbance. To our knowledge, apraxic agraphia due to thalamic involvement has not been reported.

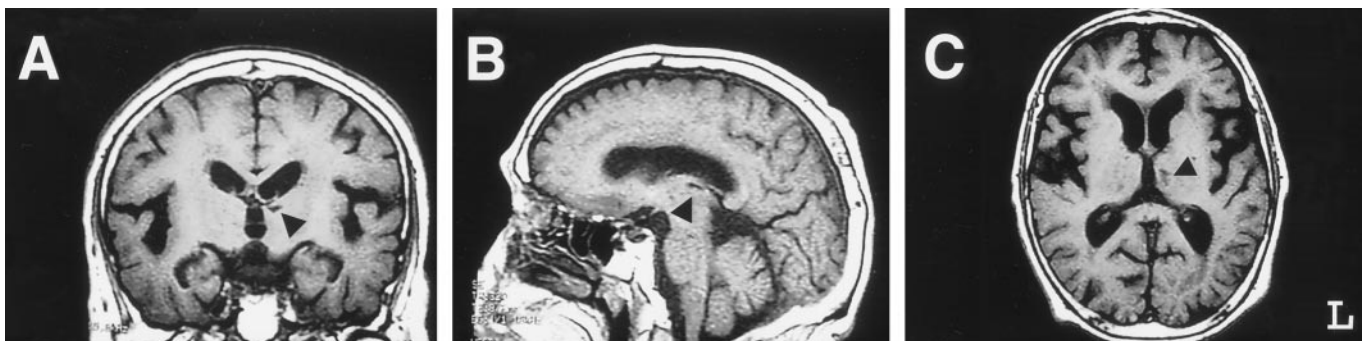


Figure 1. T1-weighted coronal (A), sagittal (B), and axial (C) images of the brain showing a left thalamic infarction. The lesion is localized in the dorsal medial nucleus.

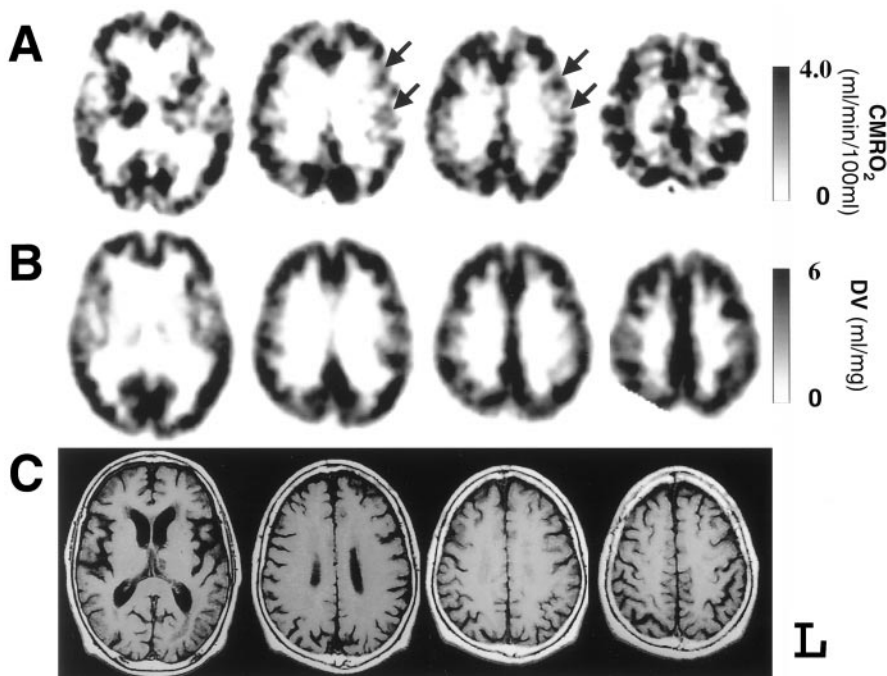


Figure 2. ^{15}O -gas-PET (oxygen metabolism; upper), FMZ-PET (distribution volume of the benzodiazepin receptor; lower middle), and T1-weighted axial (lower). ^{15}O -gas-PET shows significant hypometabolism in the left dorsolateral premotor as well as the left thalamus, while FMZ-PET shows no significant neuronal loss in the frontal lobe.

Apraxic agraphia with otherwise normal praxis was first described in 1983,¹ but its mechanism and the anatomic substrate are not clear. This syndrome is characterized by difficulty in forming written letters despite normal praxis and the preservation of oral spelling or typing. We call it pure apraxic agraphia, but most of the reported patients had such complications as aphasia, visuospatial defects, apraxia, possible agraphia due to callosal lesion, or confusion caused by a severe mass effect. True pure apraxic agraphia, therefore, has rarely been found. Although previous neuroanatomic findings suggest two main sites—the left frontal and left parietal lobes—the definite location has not been determined.

Written spelling agraphia had been classified into two subgroups.² In one, the level of visual letter imaging is disturbed⁹; in the other, the graphemic area is intact, but there is failure to reach the correct graphemic motor pattern. The lesion for the former group was proposed as being in the dominant superior parieto-occipital, and proposed for the latter as being in the frontal lobe. Our patient's agraphia can be classified in the latter. Moreover, the hypoactivated cortical area secondary to thalamic infar-

tion was in the left dorsolateral premotor area. Although a transient abnormal lesion was found in the corpus callosum, we hypothesize that it did not have an effect on the patient's agraphia. His agraphia was for both hands, which negates callosal agraphia, and his writing disorder remained even after the lesion disappeared.

While trying to clarify the mechanism of the apraxic agraphia, we noted a unique phenomenon: the patient found it easier to write kanji by describing the visual image of the letter structure. This shows that the graphemic area and the visual letter imaging are preserved enough to rebuild the letters. The patient usually wrote without using visual letter imaging, but he could write by building and copying a visual letter image. Therefore, there is damage somewhere between the graphemic area and motor programming. To clarify this phenomenon, we used the model of cognitive spelling processes (figure 3).¹⁰ The area inside the shadow suggests the site of destruction. The direct route from the visual letter imaging to handwriting, which is usually unused, is the theoretical route that explains our patient's phenomenon.

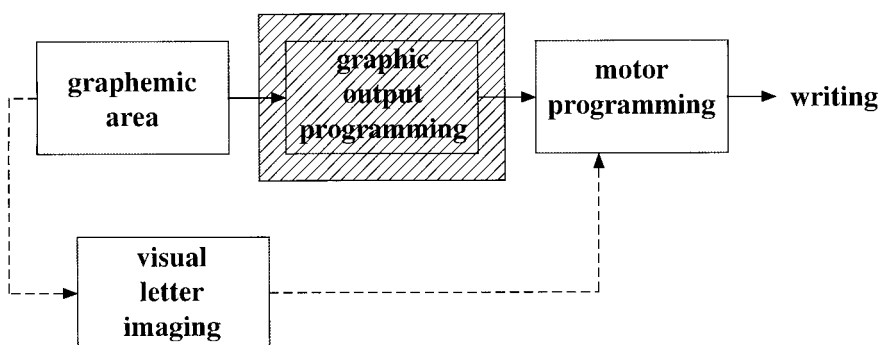


Figure 3. A model of cognitive spelling processes. Dotted lines show the new proposed route. The shadowed part is the suggested area of destruction. A direct route from the visual letter imaging to motor programming is assumed.

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Unilateral pure thalamic asterixis: Clinical, electromyographic, and topographic patterns

Article abstract—Eleven patients (nine with infarctions and two with primary hematomas) with isolated thalamic lesions and contralateral asterixis were examined using a standard electromyographic and neuroimaging protocol. Asterixis was a short-duration phenomenon associated with a hemiataxia hypesthesia syndrome in all patients. Electromechanical synchronization was constant for the two silent period types. The anatomic data strongly suggest that ventral lateral or lateral posterior thalamus are concerned in the pathophysiology of thalamic asterixis. **Key words:** Asterixis—Negative myoclonus—Thalamus—Electromyography—Stroke.

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Asterixis is defined as an abrupt, brief, arrhythmic lapse of tonically contracting muscles.¹ It is best seen in the extended wrist but can also be observed in the dorsiflexed foot or on the face. Electromyographically, asterixis is characterized by brief periods of electrical silence in muscles activated to sustain posture, and it is now considered as a form of negative myoclonus.^{2,3} Unilateral asterixis is a reliable sign of structural neurologic disease and is associated with various focal brain lesions in which the thalamus is frequently involved.^{4,5}

We report 11 cases of unilateral asterixis related to an isolated contralateral thalamic vascular lesion. Electromyographic patterns were studied for all patients. Anatomic and radiologic correlations were performed to assess the precise lesion topography.

Methods. Between 1990 and 1998, every patient admitted for stroke to the Neurology Department of the Besançon University Hospital was systematically examined for asterixis. The patients, eyes closed, were asked to hold their arms outstretched with their hands dorsiflexed at the wrist and their fingers extended and abducted. The patients were also asked to dorsiflex the ankle and to show

their teeth in order to demonstrate a leg or face asterixis. The duration of asterixis was noted.

Among 35 patients with unilateral asterixis and stroke, 28 had at least one thalamic involvement and 11 (nine with infarction and two with primary intracerebral hematoma [PIH]) had an isolated thalamic lesion and underwent a standard evaluation allowing inclusion in this study.

Electromyography (EMG) was performed in all patients with asterixis. EMG of forearm or finger flexor and extensor muscles and ankle flexor and extensor muscles was made with surface electrodes. An accelerometer was placed on the dorsum of the hand or fingers and the dorsum of the foot. For the face, the surface electrodes were placed over the levator labii superioris, the orbicularis oris, and the depressor anguli oris muscles. According to the analysis of Ugawa et al.,⁶ EMG silences were classified as silent period type I and type II. In type I, the silent period followed usual EMG background activities. In type II, the silent period followed a somewhat large EMG discharge preceded by a short EMG silence. The characteristics of this synchronization of mechanical effect and silent periods were studied in all patients.

MRI was performed in all patients using the center-to-center bicommissural plane as a reference. The site of the thalamic lesion and, for thalamic infarction, the arterial territory were systematically assessed.⁷ Standard EEG was carried out in all patients but without simultaneous EEG-EMG studies. Sensitive-evoked potentials were not measured. All patients were questioned on possible drug-induced asterixis. Laboratory studies were performed in order to rule out metabolic disorders.

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