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Short communication

# Isolated unilateral oculomotor paresis in pure midbrain stroke

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ABSTRACT

*Background and purpose:* Pure midbrain stroke can cause isolated unilateral oculomotor paresis. We attempted to determine whether there is a difference in the oculomotor paresis pattern between pure midbrain infarction and midbrain hemorrhage.
*Methods:* Pure midbrain stroke patients who presented with isolated unilateral oculomotor paresis were identified from a group of 2447 consecutive patients hospitalized for acute cerebral infarction or hemorrhage during the period May 2008 through April 2014. Detailed oculomotor findings were evaluated in the identified patients per the cause of the stroke.
*Results:* Five patients with infarct and 1 with hemorrhage became our study subjects. Lesions were located in the paramedian area of the midbrain involving the oculomotor fascicles. The pupillary sphincter and inferior rectus muscles were selectively spared in the infarct patients, whereas these muscles were selectively affected in the hemorrhage patient.
*Conclusion:* Fibers in the oculomotor fascicle that innervate the levator palpebrae, superior rectus, and inferior oblique muscles appear to be more susceptible to ischemic damage than those that innervate the pupillary sphincter and inferior rectus muscles. Isolated impairment of the pupillary sphincter and inferior rectus muscles may be suggestive of a non-ischemic process.



## 1. Introduction

Pure midbrain stroke occasionally causes isolated unilateral oculomotor paresis without other major neurological signs, mimicking cranial mononeuropathy III, i.e., damage to the oculomotor (third cranial) nerve. In such cases, the lesions are located in the ventromedial part of the midbrain involving the oculomotor fascicles [1]. More than 10 cases of isolated unilateral oculomotor fascicular stroke have been reported [2–13]. In most of these cases, the ocular muscle palsies were partial; various combinations of intra- and/or extra-ocular muscle paresis have been described. Defining the patterns of such partial oculomotor paresis has allowed for elucidation of the arrangement of human oculomotor fascicles innervating the intra- and extra-ocular muscles [14,15]. However, differences in the pattern of oculomotor paresis related to the type of stroke have not yet been evaluated. We therefore attempted to determine whether there is a difference in the oculomotor paresis pattern between pure midbrain infarction and midbrain hemorrhage.

## 2. Methods

During the period May 2008 through April 2014, 2447 patients were admitted to our hospital for acute cerebral infarction (n = 1878) or hemorrhage (n = 569). From among these patients, we identified 6 patients with pure midbrain stroke who presented with unilateral oculomotor paresis without other neurological signs. These 6 patients became our study subjects. Patients with any other neurological sign such as dysarthria, hemiparesis, or cerebellar ataxia were excluded from the study even if they presented with unilateral oculomotor paresis. Patients with bilateral oculomotor abnormalities, suggestive of oculomotor nucleus involvement, were also excluded. Causative lesions were confirmed by computed tomography and magnetic resonance imaging upon admission. Paralyzed extra- and/or intra-ocular muscles were identified by detailed examination including the nine cardinal or diagnostic positions of gaze and the Parks–Bielschowsky 3-step test [16,17], and by measurement of eye movements captured on

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**Table 1**
Clinical features of our patients who sustained isolated oculomotor fascicular stroke.

| No. | Patient | Risk factor(s) | Cause | Pattern of muscle involvement | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Pupil | IR | MR | Lid | SR | IO |
| 1 | 58-year-old man | DM, HT | Right midbrain infarction | − | − | − | + | + | + |
| 2 | 74-year-old man | DM, HT | Left midbrain infarction | − | − | + | + | + | + |
| 3 | 66-year-old man | DM, HT | Right midbrain infarction | − | − | + | + | + | + |
| 4 | 79-year-old man | DM, HT | Left midbrain infarction | − | − | + | + | + | + |
| 5 | 71-year-old man | DM, HT | Left midbrain infarction | − | − | + | + | + | + |
| 6 | 66-year-old man | HT | Left midbrain hemorrhage | + | + | − | − | − | − |

DM, diabetes mellitus; HT, hypertension; Pupil, pupillary sphincter; IR, inferior rectus muscle; MR, medial rectus muscle; Lid, levator palpebrae muscle; SR, superior rectus muscle; IO, inferior oblique muscle; +, involved; −, spared.

photographs. The patterns of extra- and intra-ocular muscle paralysis were evaluated per type of stroke. The study was approved by the institutional ethics committee. Study patients provided verbal informed consent for photographic recordings of their eye movements.

## 3. Results

Of the 6 study patients, 5 had sustained a midbrain infarction and 1 had sustained a midbrain hemorrhage. Clinical characteristics of study patients are summarized in Table 1, and results of the imaging studies are shown in Fig. 1. Causative lesions were located strictly in the paramedian area of the midbrain, which was supplied by perforators from the posterior cerebral artery (P2 segment) [7]. All 5 infarct patients had diabetes and hypertension without any potential cardiac sources of embolism such as atrial fibrillation; the possible causes of infarct in these patients were atherothrombosis and small vessel disease.

The patients' ocular muscle palsies did not involve all of the muscles innervated by the oculomotor nucleus. In all 5 infarct patients, the pupillary sphincter and inferior rectus muscles were selectively spared (Fig. 2). The levator palpebrae superioris, superior rectus, and inferior oblique muscles were affected in these 5 infarct patients, and the medial rectus muscle was also affected in 4 of these 5 patients (Table 1). In contrast, the pupillary sphincter and inferior rectus muscles were selectively affected in the patient who sustained a midbrain hemorrhage (Fig. 3). Other extra-ocular muscles were spared in this patient (Table 1).

## 4. Discussion

We were fortunate to single out 6 patients with unilateral oculomotor paresis without other neurological signs from among a very large population of acute stroke patients. Among our 2447 patients who sustained a cerebral infarction or hemorrhage, the prevalence of isolated fascicular stroke was only 0.25% (0.27% among patients with cerebral infarction and 0.18% among patients with cerebral hemorrhage). Oculomotor paresis is a frequent clinical manifestation

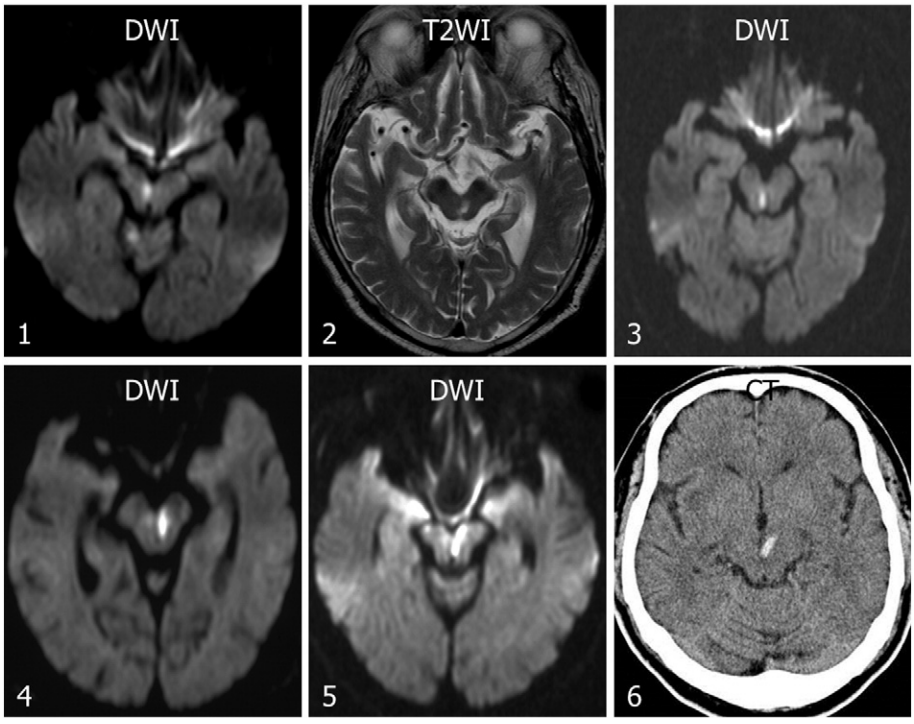


**Fig. 1.** Images obtained from our 6 patients with isolated oculomotor fascicular stroke. Shown are diffusion-weighted magnetic resonance images for Patients 1, 3, 4, and 5, T2-weighted magnetic resonance image for Patient 2, and computed tomography image for Patient 6.