Case Reports in Neurology

Case Rep Neurol 2022;14:389–396

DOI: 10.1159/000525907
Received: January 29, 2022
Accepted: July 3, 2022
Published online: October 6, 2022



**Single Case – General Neurology**

# Post Stroke Mirror Movements Preventing Performance of Bilateral Movements and Activities of Daily Living

Hokuto Suzuki[a] Satoshi Yamamoto[b] Masahiro Wakatabi[b] Hiroyuki Ohtsuka[c]

[a]Department of Rehabilitation, Zama General Hospital, Zama, Japan; [b]Department of Physical Therapy, Ibaraki Prefectural University of Health Sciences Hospital, Ibaraki, Japan; [c]Department of Physical Therapy, Showa University School of Nursing and Rehabilitation Sciences, Kanagawa, Japan

**Keywords**

Mirror movements · Cerebral infarction · Activities of daily living

**Abstract**

Mirror movements (MMs) are involuntary synchronous movements of one limb during voluntary movements of the contralateral limb. Generally, MMs after stroke are observed in the unaffected hand during voluntary movements of the affected hand; MMs in the affected hand are comparatively rare. In previous studies, evaluation of MMs in the affected hand was performed using simple unilateral movement tasks, such as tapping or forceful repeated hand closure. However, the impact of MMs of the affected hand on functional tasks, such as activities of daily living (ADLs), has not been reported. We report the rare case of a patient with MMs of the affected hand due to atherothrombotic cerebral infarction of the right postcentral and precentral gyri. An 85-year-old Japanese man presented with left-sided hemiplegia and sensory impairment. MMs were observed in the left (affected) hand during many ADLs and could not be suppressed by the patient's will even when the examiner verbally instructed the patient to move only the unaffected hand. The patient was aware that his hand moved on its own, but he could not control it. The patient was trained on various types of bilateral coordinated motor exercises for 114 days after the MMs were first identified. However, this did not affect MM occurrence, and the MMs remained at the time of discharge. Future research is necessary to plan long-term interventions for MMs of the affected hand.



Correspondence to:
Satoshi Yamamoto, yamamotos.jpn@gmail.com

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## Introduction

Mirror movements (MMs) are involuntary synchronous movements of one limb during voluntary movements of the contralateral limb [1]. Physiological MMs can be seen in healthy children up to 10 years of age, and their severity decreases with motor development [2–4]. Pathological MMs in adults are caused by central nervous system dysfunction, such as that due to stroke [5–9]. In general, MMs after a stroke are observed in the unaffected hand during voluntary movements of the affected hand. In contrast, MMs in the affected hand during voluntary movements of the unaffected hand are rare [1, 10–12]. Evaluation of MMs in the affected hand has been performed using simple unilateral movement tasks [1, 10, 12]. However, the impact of MMs of the affected hand on functional tasks, such as on activities of daily living (ADLs), has not been reported. We perform several bilateral hand coordination movements as part of our daily activities. If MMs occur on the affected side because of unaffected hand movements, it is possible that the involuntary movements may inhibit ADL execution by disrupting the coordination of bilateral hand movement. In the present case report, we describe the case of a patient with MMs in the affected hand due to stroke, and we describe the patient's neuropsychological assessment and report our findings.

## Case Presentation

An 85-year-old Japanese right-handed man was admitted to an acute-care hospital because of gait disturbance. Diffusion-weighted imaging on admission showed areas of hyperintensity in a large region of the right postcentral gyrus and a small region of the right precentral gyrus (Fig. 1), and the patient was diagnosed with atherothrombotic brain infarction. He had history of treatment for diabetes, prostatic hypertrophy, postoperative bladder cancer, and symptomatic epilepsy. He was transferred to a convalescent rehabilitation hospital on the 43rd day post onset and was discharged to a nursing home 174 days post onset.

Motor paralysis of the patient's upper limbs, rated according to the Brunnstrom stages (I, flaccidity; II, synergies and/or some spasticity; III, marked spasticity; IV, out of synergy and less spasticity; V, selective motor control; VI, near-normal isolated/coordinated movement), was judged to be at stage V on the left side 80 days post onset; the somatosensory deficit in the left upper limb was severe at 80 days. There were no motor or somatosensory deficits in the right upper limb. The biceps and triceps brachii reflexes of the left upper limb were hyperreflexive. Hoffmann's reflex and Tromner's reflex for the left upper limb were negative. Mild cognitive impairment was also observed (22/30 points in the Mini Mental State Examination).

MMs had not been observed prior to admission to the acute-care hospital. We first identified MMs on the 80th day post onset. MMs in the affected left hand were observed during the performance of numerous ADLs. When the patient tried to gesture using the unaffected right hand (such as waving, forming a fist), synchronized MMs were observed in the affected left hand (Fig. 2a, b; online suppl. Video; for all online suppl. material, see www.karger.com/doi/10.1159/000525907). The MMs in the affected hand could not be suppressed even when the examiner verbally instructed the patient to only perform movements with the unaffected hand. In addition, MMs of the unaffected right hand were not observed during the voluntary movement of the affected left hand. MMs were absent from the lower limbs. Movement disorders such as tremor, hemichorea-hemiballismus, and hemidystonia were not observed during movement of the affected hand.

While performing bilateral upper extremity tasks using tools, the affected hand is needed to support object manipulation performed using the unaffected hand to stabilize objects. The

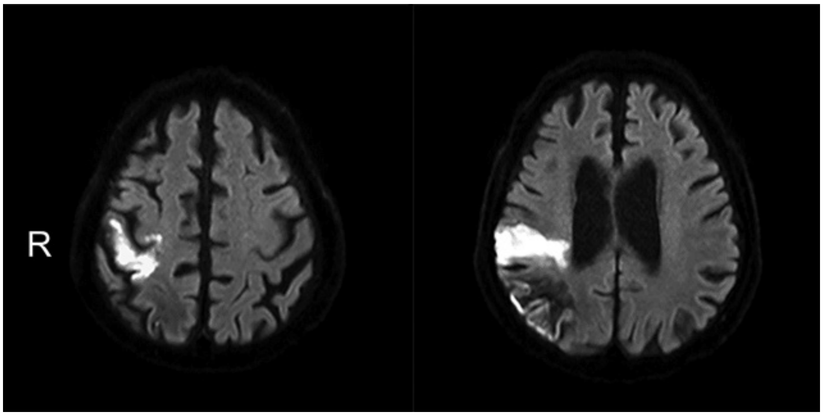


**Fig. 1.** Magnetic resonance imaging findings. Diffusion-weighted imaging on admission showing infarction in a large region of the right postcentral gyrus and a small region of the right precentral gyrus.

patient could not use the affected hand to support performing tasks such as using a mallet or saw (Fig. 2c; online suppl. Video), nail puller, spoon, or eraser (Fig. 2d); flipping over a page; cutting a piece of paper with scissors; tying a string; and folding a piece of paper. For example, when the patient performed the movement of rubbing an eraser back and forth on a piece of paper with the unaffected hand, MMs in the affected hand were observed synchronizing with the movements of the unaffected hand, and he could not hold the piece of paper. When the patient used a saw with the unaffected hand, MMs in the affected hand synchronized with the movements of the unaffected hand.

The patient complained of having no control over his hand movements and that the hand felt unnatural (as if it was not his hand). We proposed the implementation of a rehabilitation program to reduce the occurrence of MMs, and the patient complied. Repetitive practice of actual movements was conducted to suppress the MMs of the affected hand during unaffected hand movements associated with bilateral hand movements. For example, the participant was asked to perform tasks that required him to stabilize the affected hand, such as using erasers, scissors, and executing writing tasks. He was repeatedly trained to voluntarily stabilize the affected hand by visually confirming whether MMs occurred or by providing feedback to the therapist. In addition to the bilateral upper extremity tasks, the following exercises were performed using only the affected hand: peg manipulation using a pegboard, transferring a ring, and wiping a table with a cloth. The exercises were performed 40 min daily for 114 days. However, the MMs persisted and were still present at the time of discharge.

## Discussion/Conclusion

Movement disorders, such as hemichorea-hemiballismus, hemidystonia, and isolated tremor, are observed in only 0.8% of patients with acute stroke. Although these are rarely observed, a differential diagnosis is necessary to determine the type of movement disorder that is occurring [13]. In the present case, synchronous movement of the affected hand due to unaffected hand movement was observed, and no tremor, hemichorea-hemiballismus, and hemidystonia were observed during affected hand movement. Cases of hemichorea-hemiballismus and the occurrence of MMs have been reported [14]; however, it is suspected that MMs occurred independently of other movement disorders in this case.

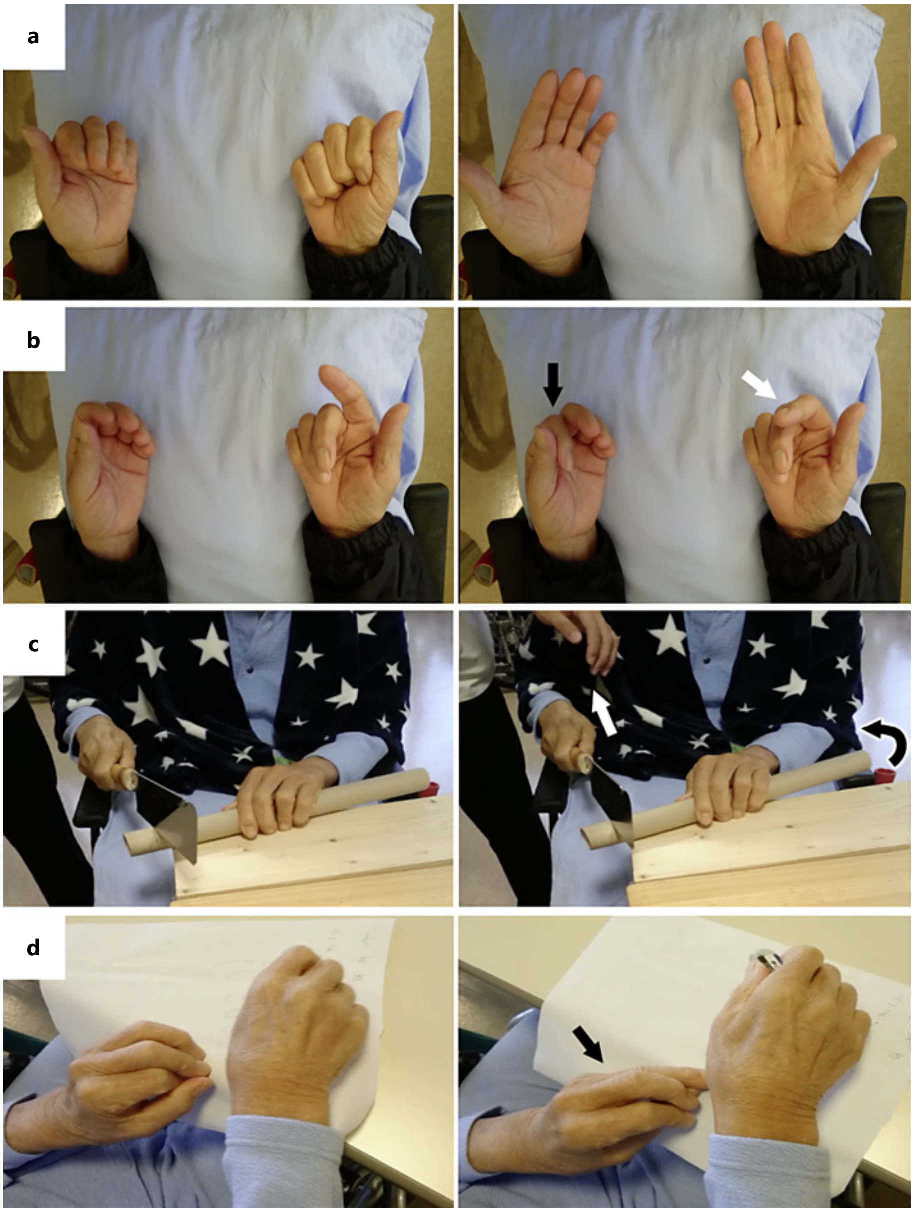


**Fig. 2.** Mirror movements (MMs) during unilateral and bilateral hand movements. During movement of the unaffected right hand, MM appears in the affected left hand. **a** The examiner instructs the patient to perform flexion and extension of the fingers using only the right hand, but flexion and extension of the fingers also occur in the left hand. **b** The examiner instructs the patient to perform flexion and extension of the right index finger (white arrow), but flexion and extension of the left index finger also occur (black arrow). **c** Operation of a saw with the right hand. As the right hand is used to operate the saw (white arrow), the left hand flexes, and the tube held with the left hand is not stable (black arrow). **d** Using an eraser with the right hand. When the eraser is rubbed against the desk with the right hand, the left hand, which is holding a piece of paper, falls off the desk (black arrow).

In the present patient, MMs of the affected hand were observed during and interfered with the performance of several ADLs, including unilateral and bilateral tasks. In a previous study, MMs in the affected hand were evaluated via simple unilateral movements of the unaffected hand, such as active pronation and supination of the forearm, flexion, extension

**Table 1.** The tasks of observing MMs in affected left hand

| Task |
|---|
| Unaffected right-hand task |
| Waving |
| Forming a fist |
| Gesture of rock-scissors-paper |
| Using a spoon |
| Flipping over pages |
| Bilateral hand task |
| Hitting with a mallet |
| Using a saw |
| Using an eraser |
| Cutting a paper with scissors |
| Tying a string |
| Folding a piece of paper |

movements of the wrist, independent finger movements, rapid finger tapping [10], and grip tasks [1, 12]. Here, we report one of the first cases of stroke-induced MMs of the affected hand elicited by movements of the unaffected hand observed during the execution of bilateral upper limb tasks and the performance of ADLs.

MMs were observed in the resting affected hand during unilateral movements of the unaffected hand (Fig. 2). Moreover, MMs were also observed in the active affected hand when the patient attempted to stabilize objects with the affected hand and to use tools with the unaffected hand (e.g., using a hammer, using a saw, using an eraser, cutting a piece of paper with scissors) (Table 1). These observations suggested that the MMs in the present patient were not elicited by specific movements, but by any movement of the unaffected hand. Furthermore, it was shown that the MMs of the affected hand were large, involuntary movements occurring even when the affected hand was in sustained voluntary contraction to support the unaffected hand or to stabilize an object.

Various forms of bilateral coordinated movement training were employed to improve the patient's ability to perform ADLs. However, even after 40 min of training per day for 114 days, the MM symptoms did not improve, and the affected hand could not be used to assist the unaffected hand. The clinical progression of this case is in line with that reported by a previous study [11]. Etoh et al. [11] reported that MMs were caused in the affected hand by temporal movement of the unaffected hand. Unaffected side opening and closing exercises were performed with ball gripping on the affected side, which slightly suppressed the MMs. Thus, our case findings and those of Etoh et al. [11] imply that MMs generated in the affected hand after stroke may be prolonged.

Various interventions have been reported to be effective for motor training aiming at functional recovery of the affected hand [15–18]. In the present study, we implemented interventions including exercises using the affected hand alone as well as bilateral upper extremity tasks [17]. In addition to these interventions, mirror therapy has also been reported as an effective motor intervention for functional recovery of the affected hand. In mirror therapy, a mirror is used to reflect the moving unaffected hand in the position of the affected hand, affording the patient the illusion that the affected hand is moving [19–21]. In cases such as the present one, where MMs of the affected hand were caused by unaffected hand movements, it may be preferable to avoid applying mirror therapy because of the risk of exacerbating the MMs. Further study is needed to develop an effective training program for the affected hand.

The duration of the intervention and follow-up period are limitations of our study. Ohtsuka et al. [8] reported the case of a patient with stroke and MMs in the unaffected hand where the effects associated with affected hand function gradually decreased over 13 months. Ejaz et al. [9] examined the progress of 53 patients with stroke from onset to 370 days after stroke and reported that MMs appeared early after stroke and decreased with functional recovery of the affected hand. Furthermore, Kim et al. [22] reported the case of a patient with congenital MMs lasting 10 years, from the age of 9 to 19 years, whose MMs improved more than expected. In our case, the interventional period lasted 114 days, which may have been too short to observe improvement in the MMs, and it is not clear whether the patient continued to experience problems or showed improvement in his ADLs after discharge. In future research, it will be necessary to implement long-term interventions for MMs on the paralyzed side for several months or years. The second limitation is the mechanism of MMs in this case. Various neural mechanisms have been postulated to be involved in MMs, such as ipsilateral corticospinal pathways, bilateral motor neuron branching, bilateral motor cortex activity associated with interhemispheric contacts, and common inputs from higher motor areas to bilateral motor cortex [23]. Neurophysiological tests such as electroencephalography, evoked electromyography, and coherence analysis are necessary to clarify the mechanism of MMs [11, 23–27]. Therefore, these neurophysiological tests should be conducted in the future to clearly elucidate the mechanism of post stroke MMs and its relationship to our clinical findings.

### Acknowledgements

We would like to thank Mika Hirata of Zama General Hospital for her assistance in providing the patient data and preparing this manuscript. We would like to thank Editage (www.editage.com) for English language editing.

### Statement of Ethics

This retrospective review of patient data did not require ethical approval in accordance with local/national guidelines (The Japanese Ministry of Health, Labour and Welfare's Ethical Guidelines for Medical and Health Research Involving Human Subjects). Written informed consent was obtained for publication of the details of the medical case and any accompanying images from the patient's daughter on behalf of the patient himself.

### Conflict of Interest Statement

There were no conflicts of interest related to this study.

### Funding Sources

This study was supported for article processing charges by a grant from JSPS-KAKENHI (No. JP19K19835). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

## Author Contributions

Hokuto Suzuki: conceptualization, investigation, writing – original draft, and visualization. Satoshi Yamamoto: conceptualization, writing – review and editing, and project administration. Masahiro Wakatabi: conceptualization, writing – review and editing. Hiroyuki Ohtsuka: conceptualization, writing – review and editing and funding acquisition.

## Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

## References

1 Nelles G, Cramer SC, Schaechter JD, Kaplan JD, Finklestein SP. Quantitative assessment of mirror movements after stroke. Stroke. 1998 Jun;29(6):1182–7.
2 Connolly K, Stratton P. Developmental changes in associated movements. Dev Med Child Neurol. 1968 Feb;10(1):49–56.
3 Mayston MJ, Harrison LM, Stephens JA. A neurophysiological study of mirror movements in adults and children. Ann Neurol. 1999 May;45(5):583–94.
4 Koerte I, Eftimov L, Laubender RP, Esslinger O, Schroeder AS, Ertl-Wagner B, et al. Mirror movements in healthy humans across the lifespan: effects of development and ageing. Dev Med Child Neurol. 2010 Dec;52(12):1106–12.
5 Kim YH, Jang SH, Chang Y, Byun WM, Son S, Ahn SH. Bilateral primary sensori-motor cortex activation of post-stroke mirror movements: an fMRI study. Neuroreport. 2003 Jul 18;14(10):1329–32.
6 Rocca MA, Mezzapesa DM, Comola M, Leocani L, Falini A, Gatti R, et al. Persistence of congenital mirror movements after hemiplegic stroke. AJNR Am J Neuroradiol. 2005 Apr;26(4):831–4.
7 Lee MY, Choi JH, Park RJ, Kwon YH, Chang JS, Lee J, et al. Clinical characteristics and brain activation patterns of mirror movements in patients with corona radiata infarct. Eur Neurol. 2010;64(1):15–20.
8 Ohtsuka H, Matsuzawa D, Ishii D, Shimizu E. Longitudinal follow-up of mirror movements after stroke: a case study. Case Rep Neurol Med. 2015;2015:354134.
9 Ejaz N, Xu J, Branscheidt M, Hertler B, Schambra H, Widmer M, et al. Evidence for a subcortical origin of mirror movements after stroke: a longitudinal study. Brain. 2018 Mar 1;141(3):837–47.
10 Radhakrishnan K, Koshy E, Prakash C. Ataxic hemiparesis and mirror movements. J Neurol Neurosurg Psychiatry. 1981 Feb;44(2):190.
11 Etoh S, Noma T, Matsumoto S, Kamishita T, Shimodozono M, Ogata A, et al. Stroke patient with mirror movement of the affected hand due to an ipsilateral motor pathway confirmed by transcranial magnetic stimulation: a case report. Int J Neurosci. 2010 Mar;120(3):231–5.
12 Caronni A, Sciume L, Ferpozzi V, Blasi V, Castellano A, Falini A, et al. Mirror movements after stroke suggest facilitation from nonprimary motor cortex: a case presentation. PM R. 2016 May;8(5):479–83.
13 D'Olhaberriague L, Arboix A, Marti-Vilalta JL, Moral A, Massons J. Movement disorders in ischemic stroke: clinical study of 22 patients. Eur J Neurol. 1995 Dec;2(6):553–7.
14 Jiang S, Zhong D, Yan Y, Zhu Q, Wang C, Bai X, et al. Mirror movements induced by hemiballism due to putamen infarction: a case report and literature review. Ann Transl Med. 2020 Jan;8(1):19.
15 Taub E, Uswatte G, King DK, Morris D, Crago JE, Chatterjee A. A placebo-controlled trial of constraint-induced movement therapy for upper extremity after stroke. Stroke. 2006 Apr;37(4):1045–9.
16 Langhorne P, Coupar F, Pollock A. Motor recovery after stroke: a systematic review. Lancet Neurol. 2009 Aug;8(8):741–54.
17 Cauraugh JH, Lodha N, Naik SK, Summers JJ. Bilateral movement training and stroke motor recovery progress: a structured review and meta-analysis. Hum Mov Sci. 2010 Oct;29(5):853–70.
18 Langhorne P, Bernhardt J, Kwakkel G. Stroke rehabilitation. Lancet. 2011 May 14;377(9778):1693–702.
19 Ramachandran VS, Rogers-Ramachandran D, Cobb S. Touching the phantom limb. Nature. 1995 Oct 12;377(6549):489–90.
20 Altschuler EL, Wisdom SB, Stone L, Foster C, Galasko D, Llewellyn DME, et al. Rehabilitation of hemiparesis after stroke with a mirror. Lancet. 1999 Jun 12;353(9169):2035–6.
21 Thieme H, Morkisch N, Mehrholz J, Pohl M, Behrens J, Borgetto B, et al. Mirror therapy for improving motor function after stroke. Cochrane Database Syst Rev. 2018 Jul 11;7:CD008449.
22 Kim ED, Kim GW, Won YH, Ko MH, Seo JH, Park SH. Ten-year follow-up of transcranial magnetic stimulation study in a patient with congenital mirror movements: a case report. Ann Rehabil Med. 2019 Aug;43(4):524–9.

DOI: 10.1159/000525907



23 Carson RG. Neural pathways mediating bilateral interactions between the upper limbs. Brain Res Brain Res Rev. 2005 Nov;49(3):641–62.
24 Farmer SF, Ingram DA, Stephens JA. Mirror movements studied in a patient with Klippel-Feil syndrome. J Physiol. 1990 Sep;428(1):467–84.
25 Mayer M, Botzel K, Paulus W, Plendl H, Prockl D, Danek A. Movement-related cortical potentials in persistent mirror movements. Electroencephalogr Clin Neurophysiol. 1995 Nov;95(5):350–8.
26 Farmer SF, Harrison LM, Mayston MJ, Parekh A, James LM, Stephens JA. Abnormal cortex-muscle interactions in subjects with X-linked Kallmann's syndrome and mirror movements. Brain. 2004 Feb;127(Pt 2):385–97.
27 Cincotta M, Borgheresi A, Balestrieri F, Giovannelli F, Ragazzoni A, Vanni P, et al. Mechanisms underlying mirror movements in Parkinson's disease: a transcranial magnetic stimulation study. Mov Disord. 2006 Jul;21(7):1019–25.