

Fig. 3. (A) Subsequent Axial 2D time-of-flight MRA, demonstrated persistent medial displacement and rotation of the ICA (arrow) with the head in a neutral position. (B) MRI: Axial T1-weighted imaging, head turned to the right, demonstrated restoration of the normal anatomic position of the ICA (arrow).

able considering the minimal morbidity and allows the patient physical and psychological freedom with neck movement.

4. Conclusion

Hyoid bone impingement of the carotid artery should be considered in stroke of indeterminate aetiology especially in the presence of neck, throat, ear pain, repetitive neck movements and prolonged neck position. CTA neck with head rotation may be used for initial screening.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jocn.2019.03.040>.

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Mirror writing after perimesencephalic subarachnoid haemorrhage

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ABSTRACT

We report a case of a right-handed Caucasian woman who developed mirror writing following a non-aneurysmal, non-traumatic subarachnoid haemorrhage. The patient was unaware of having this phenomenon, and it was detected by clinical staff when the patient was writing a card to a family member. Serial imaging has ruled out a stroke as well as an underlying vascular abnormality. This phenomenon resolved after two months. Whilst there is a body of literature surrounding mirror writing, to our knowledge, this is the first description of mirror writing in the setting of a perimesencephalic subarachnoid haemorrhage.

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1. Case summary

A 59-year-old right-handed Caucasian woman presented with sudden onset, severe, thunderclap headache and vomiting. Computer tomography (CT) of the head revealed moderate volume subarachnoid blood within the interpeduncular, ambient, prepontine, and medullary cisterns, extending into the suprasellar cistern and proximal left sylvian fissure, and a small haematoma within the foramen of Magendie (Fig. 1).

At the time of admission, she had a Glasgow Coma Scale (GCS) score of 14/15, with eye-opening to voice, but no neurological deficit. The patient was an active smoker, and had a known history of treated breast cancer. There was no history of trauma. She had completed high school education and worked as a counsellor.

Blood pressure remained well controlled throughout her admission, and she never exhibited weakness or sensory disturbance. CT angiogram as well as Digital Subtraction Angiogram (DSA), performed on the day of admission did not show an aneurysm or other vascular lesion. On day 3 of admission, she developed Syndrome of inappropriate ADH release (SiADH), with a sodium nadir of 120 mmol/L. This was managed with hypertonic saline, improving to 127 mmol/l over 24 h and 135 mmol/L at another 48 h.

MRI/MRA of the brain and cervical spine on day 3 showed a small focal acute infarct within the right occipital subcortical white matter but no evidence of vasospasm or underlying vascular lesion. An MRI/A brain performed one week later demonstrated incidental focal narrowing of the right P1 segment, likely due to vasospasm. The previous focal occipital infarct was not visible.

During her admission, she had regular occupational therapy reviews, scoring 12/30 on the Montreal Cognitive Assessment tool (Fig. 2). Major deficits were visuospatial, memory, language and orientation, with numbers on the clock-face task running in an anticlockwise order but the numbers not being mirrored. On day 12 of admission, she was noted to have more pervasive mirror writing when writing a card (Fig. 3). A brain CT angiogram demonstrated basilar as well as bilateral P1 segment narrowing.

Serial imaging since her hospital discharge remains unremarkable. Over the following two months, she became increasingly aware of her mirror writing, and it resolved.

2. Discussion

Mirror writing is an unusual script, in which text runs in the opposite direction to normal and with letters reversed [1,2]. When held to a mirror, such words can be read normally. The phenomenon itself is highly heterogeneous, with writing ranging from a single reversed letter, through numerous reversed letters but not words, to occasional mirrored words, and even complete pages of script [2]. Numerals and visual engrams may also be reversed too.

In otherwise healthy individuals, the phenomenon is seen, for example, in children who are learning to write, as well as in right-handed adults when they are required to write with their unaccustomed hand [3]. It is almost always undertaken with the left hand [2], with left-handed individuals and those whose languages are written leftwards, such as Japanese, Chinese, Hebrew and Arabic, tending to exhibit more this phenomenon [2,3].

Pathological mirror writing is mostly commonly seen in the setting of stroke. However, even then, the incidence is low, with reports varying between 2.5 and 13 percent, and almost invariably involves damage to the left hemisphere. Other circumstances in which mirror writing can manifest is in focal or diffuse brain trauma, and degenerative brain diseases such as Parkinson's disease and spinocerebellar degeneration [2,4]. Given the variety of conditions in which this phenomenon can manifest, it is clear that there is no single structure involved. Indeed, mirror writing has been reported in patients with isolated lesions involving, right supplementary motor area, medial prefrontal cortex, anterior cingulate gyrus, left basal ganglia and left parietal lobe [2,5–11].

Multiple theories exist regarding why mirror writing can develop, ranging from motor centre, spatial-orientation, visual, and thalamo-cortical circuitry hypotheses [6,12]. However, the unifying feature of these is that mirror writing is almost always carried out with the left hand, and is often associated with other, more pervasive phenomena, such as mirrored reading, right-left perceptual difficulties, and dyslexia [6,12]. Our case is unique in that our patient exhibited mirror writing with the right hand, and without other features such as mirrored reading or mirrored engrams.

Whilst our patient did exhibit a delayed ability to differentiate left from right, overall, she was correct in her responses such as naming various left- and right-sided body parts. The most notable example of her left-right disorientation was during her completion of the clock-face drawing task on the Montreal Cognitive Assessment tool, whereby numbers were ordered in an anticlockwise direction but the numbers themselves were not mirrored. She was still able to copy a cube in the conventional fashion. It is difficult to determine whether other objects she drew were mirrored, as those witnessed, such as hearts and crosses, have lines of symmetry. The patient also was able to read in the conventional Western fashion. She also exhibited anosognosia and anosodiaphoria regarding her writing. However, interestingly, over two months, her mirrored writing became less frequent as she became increasingly aware of and concerned by this trait.

Both the cause of her subarachnoid haemorrhage and mirrored writing remains uncertain. However, the radiology findings of basilar artery and proximal P1 segment narrowing, concerning for vasospasm, could suggest that the patient's mirror writing was due to cerebral ischaemia. Interestingly, the patient developed profound hyponatraemia early during her admission (day 3). Several studies have demonstrated an association between hyponatraemia



Fig. 1. CT brain on the day of admission, demonstrating subarachnoid blood within the basal cisterns.

04/07/18

MONTREAL COGNITIVE ASSESSMENT (MOCA)
Version 7.1 Original Version

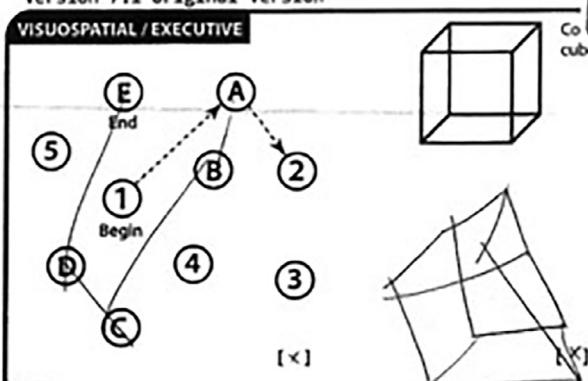
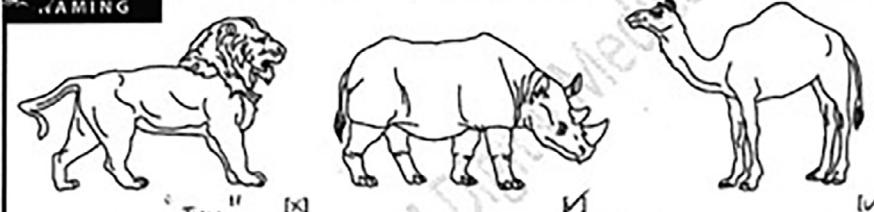
VISUOSPATIAL / EXECUTIVE  <p style="text-align: right;">1/5</p>	NAMING  <p style="text-align: right;">2/3</p>																		
MEMORY <small>Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.</small> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;"></td> <td style="width: 15%; text-align: center;">FACE</td> <td style="width: 15%; text-align: center;">VELVET</td> <td style="width: 15%; text-align: center;">CHURCH</td> <td style="width: 15%; text-align: center;">DAISY</td> <td style="width: 15%; text-align: center;">RED</td> </tr> <tr> <td style="text-align: center;">1st trial</td> <td style="text-align: center;">✓</td> </tr> <tr> <td style="text-align: center;">2nd trial</td> <td style="text-align: center;">✓</td> </tr> </table> <p style="text-align: right;">No points</p>			FACE	VELVET	CHURCH	DAISY	RED	1st trial	✓	✓	✓	✓	✓	2nd trial	✓	✓	✓	✓	✓
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2nd trial	✓	✓	✓	✓	✓														
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<small>new list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors</small> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 100%; text-align: center;">[✓] F B A C M N A A J X K L B A F K D E A A A J A M O F A A B</td> </tr> </table> <p style="text-align: right;">1/1</p>		[✓] F B A C M N A A J X K L B A F K D E A A A J A M O F A A B																	
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[X] 93	[✓] 86	[✓] 79																	
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ORIENTATION <small>[X] Date, [X] Month, [X] Year, [X] Day, [X] Place, [✓] City</small> <p style="text-align: right;">1/6</p>																			
© Z.Nasreddine MD www.mocatest.org Normal ≥ 26 / 30 TOTAL 12/30																			
Administered by: Ellen J. Miller (OT) 04/07/18 Add 1 point if ≤ 12 years old																			

Fig. 2. Our patient's Montreal Cognitive Assessment (MOCA), demonstrating deficits across multiple cognitive domains.

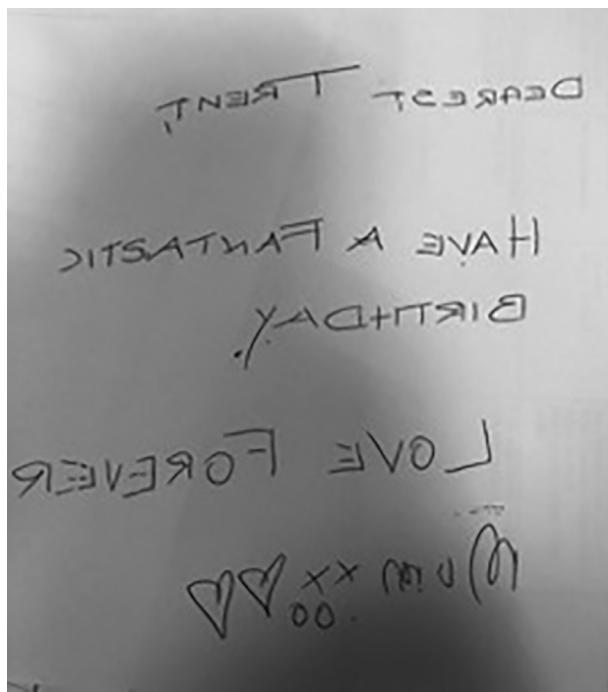


Fig. 3. A handwritten card from the patient, noted on day 12 of admission.

and delayed ischaemic neurological deficits, which can include features as subtle as mental state changes [13–17].

This case outlines an interesting, rare and transient phenomenon in a right-handed patient after a perimesencephalic subarachnoid haemorrhage. To our knowledge this is the first reported such case in the literature.

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Declarations of interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jocn.2019.03.039>.

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