The correlation between lateralization of intracerebral hemorrhage in basal ganglia and handedness[1]

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ABSTRACT

PURPOSE: To investigate the correlation between lateralization of cerebral basal ganglia hemorrhage and handedness.

METHODS: Medical records and computed tomography (CT) scans for 84 patients with primary hypertensive intracerebral hemorrhage (ICH) in basal ganglia were reviewed. Data of gender, age, handedness, and location of basal ganglia hematoma were statistically analyzed. Data of age, gender, handedness, health condition, and mean blood flow velocity (BFV) in middle cerebral arteries (MCAs) and anterior cerebral arteries (ACAs) on both sides of 114 healthy individuals were statistically analyzed.

RESULTS: We found out that the patients with right basal ganglia hemorrhage were mostly left-handed, while patients with left basal ganglia hemorrhage were mostly right handed ($p=0.021$, $r=0.251$). And the mean BFV in the right MCAs of left-handed ones are relatively higher, the mean BFV in the left MCAs of right-handers are relatively higher ($p=0.008$, $r=0.248$).

CONCLUSION: There's a correlation between lateralization of cerebral basal ganglia hemorrhage and handedness.

Key words: Intracerebral hemorrhage. Blood Flow Velocity. Handedness. Lateralization. Transcranial Doppler.

Introduction

Spontaneous intracerebral hemorrhage (ICH) accounts for 10% to 30% of all strokes[1]. There are several modifiable risk factors for spontaneous ICH. Hypertension is by far the most important and prevalent risk factor, directly accounting for about 60% to 70% of cases[2,3]. Hypertensive ICH typically occurs in the basal ganglia (putamen, thalamus, or caudate nucleus), pons, cerebellum, or deep hemispheric white matter[4]. More than 50% of all spontaneous ICH occurs in the basal ganglia[5]. Furthermore, based on the hematoma location, basal ganglia hemorrhages can be divided into left basal ganglia hemorrhages and right basal ganglia hemorrhages.

Most humans exhibit some degree of handedness, which is a preference to use one hand for tasks requiring precise coordination, exact calibration of forces, and accurate timing[6,7].

During the clinical work, we found that most of the left-handed patients suffered right basal ganglia hemorrhage, while most of the right-handed ones suffered left basal ganglia hemorrhage.

However, there's no identical article which straight forwardly reported this correlation or furthermore explained it. We doubted that whether there was a correlation between lateralization of cerebral basal ganglia hemorrhage and handedness. Medical records and computed tomography (CT) scans for 84 patients with primary hypertensive intracerebral hemorrhage (ICH) in basal ganglia presented to the emergency service center and admitted to the neurology department of our hospital between January 2010 and January 2011 were reviewed to verify the previously mentioned correlation.

Hemispheric dominance is expressed by cerebrum areas mainly supplied by the MCAs, and the basal ganglia regions which belong to the cerebrum are also supplied by the MCAs.

To figure out the reason of the correlation mentioned above, we measured the mean blood flow velocities in both the left MCA and right MCA of 114 individuals with no clinical signs of cerebrovascular diseases via transcranial Doppler to figure out whether there was a correlation between handedness and the mean blood flow velocity asymmetry of MCAs under resting condition. For the ACAs also supply the cerebrum, we measured the mean blood flow velocities of ACAs from the 114 individuals to make a contrast.

Methods

The design was composed of two phases: a correlation verification phase and a correlation explanation phase.

During the correlation-verification phase, 84 patients (38 women, 46 men, aged from 34 to 85, average age 59) with primary hypertensive intracerebral hemorrhage (ICH) in basal ganglia were selected. They were presented to the emergency service center and admitted to the neurology department of our hospital between January 2010 and January 2011 and phone calls were made to them or their families to verify relative information if necessary. The subjects were divided into 2 groups: the left-handed, and the right-handed. To assess the handedness of subjects, we consulted the 10-item version of the Edinburgh Handedness Inventory questioning the patients or the lineal relatives (some of the patients had scores of Glasgow Coma Scale (GCS) which were too low to answer the questions). The correlation between sex and the lateralization of basal ganglia hemorrhage was also statistically analyzed. Data collectors, patients, and their lineal relatives didn't know the purpose of this study.

During the correlation-explanation phase, from March 1st 2012 through March 31st 2012, 114 individuals (30 women, 84 men, aged from 22 to 89, average age 47) with no clinical signs of cerebrovascular diseases who came to the medical center for regular physical examination were given TCD tomography examination on both the MCAs and ACAs under resting condition to record the mean blood flow velocities of both the right and left sides. The datum of age, sex, and handedness, with or without hypertension, diabetes, Coronary heart disease and the familial cerebrovascular disease history were surveyed before the course of examination. All the individuals and data collectors have no idea of the aim of this study.

We used the Transcranial Doppler ultrasonograph device (TC2021-III, EME GmbH, Kleinostheim, Germany) for measuring the mean blood flow velocity. Two 2 MHz transducers were placed on the bilateral transtemporal windows. The middle cerebral arteries were identified at a depth of 46–64 mm. The software Win TCD 3.7.0 was applied. Every subject was told to lie on a flat bed with head on a 3cm thick soft pillow and was instructed to keep mute and not to move throughout data acquisition. By hand we noted the time-averaged peak frequencies (mean) calculated by the machine every 3 seconds in centimeters per second. The study was approved by the Institutional Review Board and all subjects signed informed consent according to the Declaration of Helsinki.

Statistical analysis

Pearson contingency coefficients were calculated to determine whether there is a correlation between the lateralization of cerebral basal ganglia hemorrhage and the handedness and whether the mean blood flow velocity superiority of the unilateral MCA and ACA correlated with the handedness. Statistical analysis was performed using The Statistical Package for Social Science (version 17.0 for Windows; SPSS).

Results

At the end of the first phase, we found out that 48 (six left-handed, 42 right-handed) subjects were patients with left basal ganglia hemorrhage, and 36 (12 left-handed, 24 right-handed) subjects were patients with right basal ganglia hemorrhage. As shown in Table 1: a low correlation (p=0.021, r=-0.251) was found out between the lateralization of cerebral basal ganglia hemorrhage and the handedness. However, there was no correlation (p=0.574, r=-0.062) between sex and lateralization of basal ganglia hemorrhage, and there was no correlation (p=0.940, r=0.008) between sex and handedness either in the first phase.

TABLE 1 – Correlations.

		handedness	hemorrhage	sex
handedness	Pearson Correlation	1	-.251*	.008
	Sig. (2-tailed)		.021	.940
	N	84	84	84
hemorrhage	Pearson Correlation	-.251*	1	-.062
	Sig. (2-tailed)	.021		.574
	N	84	84	84
sex	Pearson Correlation	.008	-.062	1
	Sig. (2-tailed)	.940	.574	
	N	84	84	84

*Correlation is significant at the 0.05 level (2-tailed).

Among 114 individuals in the second phase, the mean blood flow velocity in the left MCA was higher than that in right MCA in ten left-handers, and the rest ten left-handers showed an opposite outcome; while the mean blood flow velocity in the left MCA was higher than that in right MCA in 74 right-handers, the rest 20 right-handers showed an opposite outcome. Eight left-handed subjects showed a higher velocity in the left ACA, while 12 left-handed subjects showed the opposite. The mean blood flow velocities were relatively higher in the left ACA of 20 right-handed subjects, and 74 right-handed subjects showed the opposite. Twenty four subjects were excluded for the same blood flow velocities on both sides, eight subjects were excluded due to the failure of detecting the blood flow, and 15 subjects were excluded for the abnormal blood flow velocities on one or both sides[8].

As is shown in Table 2 there's a low correlation (p=0.008, r=-0.248) between the mean blood flow velocity superiority of the unilateral MCA and the handedness, and there's also a significant correlation (p=0.008, r=0.248) between the mean blood flow velocity superiority of the unilateral ACA and the handedness. However there's no correlation (p=0.597, r=0.050) between the mean blood flow velocity superiority of the unilateral MCA and sex. And there's no correlation (p=0.597, r=-0.050) between the mean blood flow velocity superiority of the unilateral ACA and sex either. And there's no correlation (p=0.884, r=0.014) between sex and handedness in the second phase. There's no correlation (p=0.136, r=-0.140) between mean blood flow velocity superiority of the unilateral MCA and ACA.

TABLE 2 - Correlations.

		handedness	BFVSUM	sex	BFVSUA
handedness	Pearson Correlation	1	-.248**	.014	.248**
	Sig. (2-tailed)		.008	.884	.008
	N	114	114	114	114
BFVSUM	Pearson Correlation	-.248**	1	.050	-.140
	Sig. (2-tailed)	.008		.597	.136
	N	114	114	114	114
sex	Pearson Correlation	.014	.050	1	-.050
	Sig. (2-tailed)	.884	.597		.597
	N	114	114	114	114
BFVSUA	Pearson Correlation	.248**	-.140	-.050	1
	Sig. (2-tailed)	.008	.136	.597	
	N	114	114	114	114

**Correlation is significant at the 0.01 level (2-tailed).
BFVSUM stands for the mean blood flow velocity superiority of the unilateral MCA,BFVSUA stands for the mean blood flow velocity superiority of the unilateral ACA

Discussion

We found out that most of the patients with right basal ganglia hemorrhage were left-handed while patients with left basal ganglia hemorrhage were mostly right handed ones (p=0.021, r=0.251). And the mean blood flow velocity in the right MCA of most of the left-handed is relatively higher; the mean blood flow velocity in the left MCA of most of the right-handers is relatively higher (p=0.008, r=0.248).

However there are still some limitations to this study: the quantity of the patients with basal ganglia hemorrhage is still too limited, and data of patients in other area (most of the patients in this study were from northeast of China) of China and other races in the world and a long term study (more than one year) are needed to make the conclusion more convincing. During the study, we found out that as the subjects accumulated, the absolute value of Pearson Correlation became higher. Also there needs to be a more accurate way to identify the handedness of the individuals.

In this study, to assess the handedness of subjects, we consulted the 10-item version of the Edinburgh Handedness Inventory[9] in questioning patients or their lineal relatives (some of the patients had scores of Glasgow Coma Scale (GCS) which were too low to answer questions). If at least two items were reported to be done with the left hand, then the subject would be regarded as a left-handed one. However, this is not the best way to classify the handedness. There are three more ways to classify the handedness: The Jones and Martin sex-linked theory of handedness[10-13], 2-allele Mendelian model[14], and the right shift (RS) theory of handedness[15-18]. However, for some limitations in this study, we can only choose the Edinburgh Handedness Inventory for the quick classification. The RS theory may be put into use for our further study.

There are some limits in the judgment. Firstly, the recognition of handedness: Some individuals don't realize that they are left-handed, and we can figure out some left-handed ones only when they remembered that they were forced to write, draw, or use chopsticks by their right hands against their will. And when the questions came to the patients' relatives, not all the relatives were sure of the handedness of the patients. Sons and daughters tended to underestimate the degree of the left-handedness of their parents which may increase the error of measurement in the survey. If they were not sure of the handedness of the patients, the patients would be excluded from this study. Secondly, the willingness to admit that they were left-handers: also due to the culture, as far as we are concerned, in some areas of the province, country or even the world, left-handed is not recognized as a good character, some think that the left-handedness is an obstacle for one's growing up.

However, how can we explain the correlation that we found out in the daily clinical work? Why do most of the left-handed and the right-handed patients with familial sinistrality suffer from the right basal ganglia hemorrhage and most right handed ones suffer from the left basal ganglia hemorrhage? All of the patients in this study had hypertension which is by far the most important and prevalent risk factor, directly accounting for about 60%-70% of the spontaneous ICH[2,3,19]. Chronic hypertension causes degeneration, fragmentation, and fibrinoid necrosis of small penetrating arteries in the brain, which can eventually result in spontaneous rupture[19]. The small penetrating arteries which ruptured to cause the basal ganglia hemorrhages derived from the MCAs. Then we can infer that maybe there is a correlation between the mean blood flow velocity in MCAs and the handedness. However, articles about this are rare. So we decided to start a study on this subject.

During the second phase, the correlation explanation phase, we found out that the mean blood flow velocities in the left and right MCA of the individuals were mostly different from each other. Of course, the abnormal values which means the mean blood flow velocity in one side of MCA is much too higher than that in the other side (the difference between the velocities of left and right MCA under 14% is considered to be normal, for the ACA, the difference is under 24%)[20]were excluded. We found that the mean blood flow velocity in the right MCA of the left-handers and right-handers with familial sinstrality is relatively higher, while the mean blood flow velocity in the left MCA of the right-handers is relatively higher. As for being with or without hypertension, diabetes, coronary heart disease and the familial cerebrovascular disease history, there weren't enough samples. So the four factors mentioned above were not analyzed. The result we found out in the second phase may explain the correlation that we found out in the first phase. Higher blood flow velocity is one of the important factors in hemorrhage. The higher blood flow velocity may cause the blood vessel to be more fragile as time accumulates. Under the hypertension, the basal ganglia hemorrhage will take place where the vessels are relatively weaker. Then we may conclude that when one is about to undertake the primary hypertensive ICH in basal ganglia, the handedness may partly and indirectly affect which side of basal ganglia is to suffer heamorrhage. Furthermore, we can explain why hemiplegic patients who suffered from basal ganglia hemorrhage in one side always suffered from basal ganglia hemorrhage in the other side. We can say that maybe one of the reasons are the use of one side limbs (of course, after the first hemorrhage in basal ganglia region, the other side limb can't move or move freely as before).

Questions come that if there was a way to make the blood flow velocities in the MCA equal on both sides so that there won't be one side of the basal ganglia region more fragile under the condition of hypertension or if there was a way to lower the risk of basal ganglia hemorrhage when one is under hypertension? The answer is not clear. Because there's no article on this subject as far as we know. The prevention of ICH are widely studied[21,22]. In this study, we can assume that maybe one can change the way of performing mental or physical activities[23]. That means the left-handers and right-handers with familial sinistrality can try to use their right hands as much as possible and the right-handed can try to use their left hands as much as they can. Or people may try to use their both hands equally in performing activities. The effectiveness of this hypothesis needs to be tested in further research. Those 114 subjects in the second phase will be followed up in the coming years.

Conclusion

There is a correlation between lateralization of cerebral basal ganglia hemorrhage and handedness.

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Acknowledgments

We thank all our colleagues who supported us in the whole course of this study.

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Received: October 15, 2012
Review: December 17, 2012
Accepted: January 18, 2013
Conflict of interest: none
Financial source: Scientific Research Fund of Liaoning Provincial Education Department of China.

[1]Research performed at Department of Neurosurgery, the First Affiliated Hospital of Liaoning Medical College, Jinzhou, China.