CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2019; 25: 418-426
DOI: 10.12659/MSM.914423

Received: 2018.12.04
Accepted: 2019.01.02
Published: 2019.01.14

New Silent Cerebral Infarction in Patients with Acute Non-Cerebral Amyloid Angiopathy Intracerebral Hemorrhage as a Predictor of Recurrent Cerebrovascular Events

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABCDEF 1 **Yuan-Wei Wang**
ABCDEFG 2 **Guo-Ming Zhang**

1 Department of Neurology, Shuyang People's Hospital, Shuyang Hospital Affiliated to Xuzhou Medical University, Shuyang, Jiangsu, P.R. China
2 Department of Laboratory Medicine, Shuyang People's Hospital, Shuyang Hospital Affiliated to Xuzhou Medical University, Shuyang, Jiangsu, P.R. China

Corresponding Author: Guo-Ming Zhang, e-mail: zly5120@163.com, gm@xzhmu.edu.cn
Source of support: This study was supported by a research grant from the Health and Family Planning Commission of Jiangsu Province (grant Q201616)

Background: The aim of this study was to investigate the incidence and related risk factors of new silent cerebral infarction in patients with acute non-cerebral amyloid angiopathy (non-CAA) intracerebral hemorrhage (ICH) and to explore clinical cerebrovascular event recurrence within 1 year.

Material/Methods: This prospective study observed 152 patients with non-CAA ICH diagnosed by computed tomography within 3 days after onset. All patients underwent magnetic resonance imaging on day 14 to identify silent cerebral infarction, and their subsequent clinical cerebrovascular events were followed up regularly within 1 year.

Results: Of the 152 patients, 46 (30.26%) had silent cerebral infarctions. Multiple logistic regression analysis revealed that the white blood cell (WBC) count, cerebral microbleeds (CMBs), and leukoaraiosis were silent cerebral infarction risk factors. At 1-year follow-up, 34 (22.37%) had clinical cerebrovascular events, with 8 (23.53%) having vascular-related deaths. Multiple logistic regression analysis showed that silent cerebral infarction was the only independent predictor of future clinical cerebrovascular events.

Conclusions: Silent cerebral infarction is common during acute non-CAA ICH and is independently related to WBC counts, CMBs, and leukoaraiosis. The risk of clinical cerebrovascular events in non-CAA ICH patients with silent cerebral infarction increases in the following year; thus, silent cerebral infarction may be a useful predictor of recurrent cerebrovascular events.

MeSH Keywords: **Cerebral Amyloid Angiopathy • Cerebral Small Vessel Diseases • Leukoaraiosis**

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/914423

1993 4 1 25

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Background

Intracerebral hemorrhage (ICH) caused higher mortality and disability rates among all types of stroke [1]. Spontaneous ICH accounts for 10–30% of all stroke cases, which seriously affects the quality of life of patients and imposes heavy economic burdens on society and family [2]. Cerebral infarction and ICH are 2 independent diseases. Although some diseases, such as cerebral amyloid angiopathy (CAA) and moyamoya disease, can cause both cerebral infarction and ICH [3], stroke patients usually only have one of them. With the development in magnetic resonance imaging (MRI) technology, especially the application of diffusion-weighted imaging (DWI), there have been continuous studies on the coexistence of cerebral infarction and ICH in stroke patients, and the detection rate is continuously increasing. Previous studies have found that silent cerebral infarction is common in patients with cerebral infarction, CAA, subarachnoid hemorrhage, and ICH [4–7]. There are many studies on DWI lesions in ICH, but there are currently only a few studies on the relationship between silent cerebral infarction and the long-term prognosis of patients. The aim of this study was to assess the risk factors of silent cerebral infarction in patients with non-CAA ICH and to explore the correlation between silent cerebral infarction and recurrent clinical cerebrovascular events within 1 year.

Material and Methods

From January 2016 to June 2017, 152 patients with acute non-CAA ICH were enrolled in the Department of Neurology, Shuyang People's Hospital, Jiangsu Province, and were regularly followed up within 1 year after onset of disease. The study was carried out in accordance with the recommendations of the 2014 Guidelines for Cerebral Hemorrhage and Cerebral Infarction in China and the Academic Committee and Ethics Committee of Shuyang People's Hospital, as well as the Declaration of Helsinki. The protocol was approved by the Academic Committee and Ethics Committee of Shuyang People's Hospital. All subjects gave written informed consent prior to their inclusion in the study.

Inclusion criteria

Patients with acute ICH for the first time whose diagnosis and neurological deficit scores were according to the criteria and scoring standards established by the Fourth National Conference on Cerebrovascular Diseases in 1996 and confirmed by computed tomography (CT) or MRI were included.

Exclusion criteria

We excluded patients with clearly identified cerebral infarction or embolism; hemorrhagic cerebral infarction; recent active bleeding, bleeding disorders, or bleeding tendency; severe heart, liver, or kidney dysfunction; platelet count $<100\times10^9$/L and fibrinogen $\leq$1.0 g/L; recent surgical and traumatic injuries; obvious surgical indications (cerebral lobe or shell nucleus hemorrhage >30 mL, cerebellar hemisphere hemorrhage >15 mL, and drainage for ventricular casting); definite vascular lesions (such as aneurysm, arteriovenous malformation, and cavernous hemangioma); or those with family members requiring craniotomy [8]. Probable and possible ICHs caused by CAA were excluded based on the modified Boston standard.

Data collection

General clinical data, laboratory data, and imaging data of the patients were collected. The severity of neurological impairment at the time of admission was evaluated by the stroke scale of the US National Institutes of Health and the Glasgow Coma Scale. All patients were diagnosed with ICH by head CT examination within 3 days, and head MRI (Germany Siemens 3.0T MR) examination was performed on the 14th day after ICH. For MRI examination, sequences included T1-, T2*-, DWI, and susceptibility-weighted imaging (SWI). All scans were performed by skilled radiologists, and image information, including silent cerebral infarction (high signal on DWI sequence), cerebral microbleeds (CMBs), and leukoaraiosis, were randomly read and recorded by 2 radiologists blinded to clinical information [9].

Silent cerebral infarction, CMBs, leukoaraiosis, and end events definition

Silent cerebral infarction was defined as a high-signal intensity lesion on DWI with accompanying low-signal intensity on ADC. The high-signal intensity lesions in the area of the hematoma and surrounding tissue were excluded [8]. Asymptomatic was defined as the absence of new symptoms such as abnormal sensation, limb weakness, or deterioration of the original nervous system function [10]. CMBs were defined as a circular and quasi-circular signal reduction shadow with a diameter of 2–5 mm on SWI, with clear boundary and no surrounding edema, and calcification, peripheral space, and small-vein vessels excluded [11,12]. Cerebral leukoaraiosis was defined as long spots, plaques, or fused long-T2 signal image of white matter around the ventricle or the central part of the hemiovoid circle [13,14].

Clinical cerebrovascular end events were defined as cerebral infarction, ICH, and subarachnoid hemorrhage. Cerebrovascular-related deaths include deaths from recurrent cerebral infarction ICH and subarachnoid hemorrhage, excluding suicide and cancer-, infection-, and cardiovascular-related deaths.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

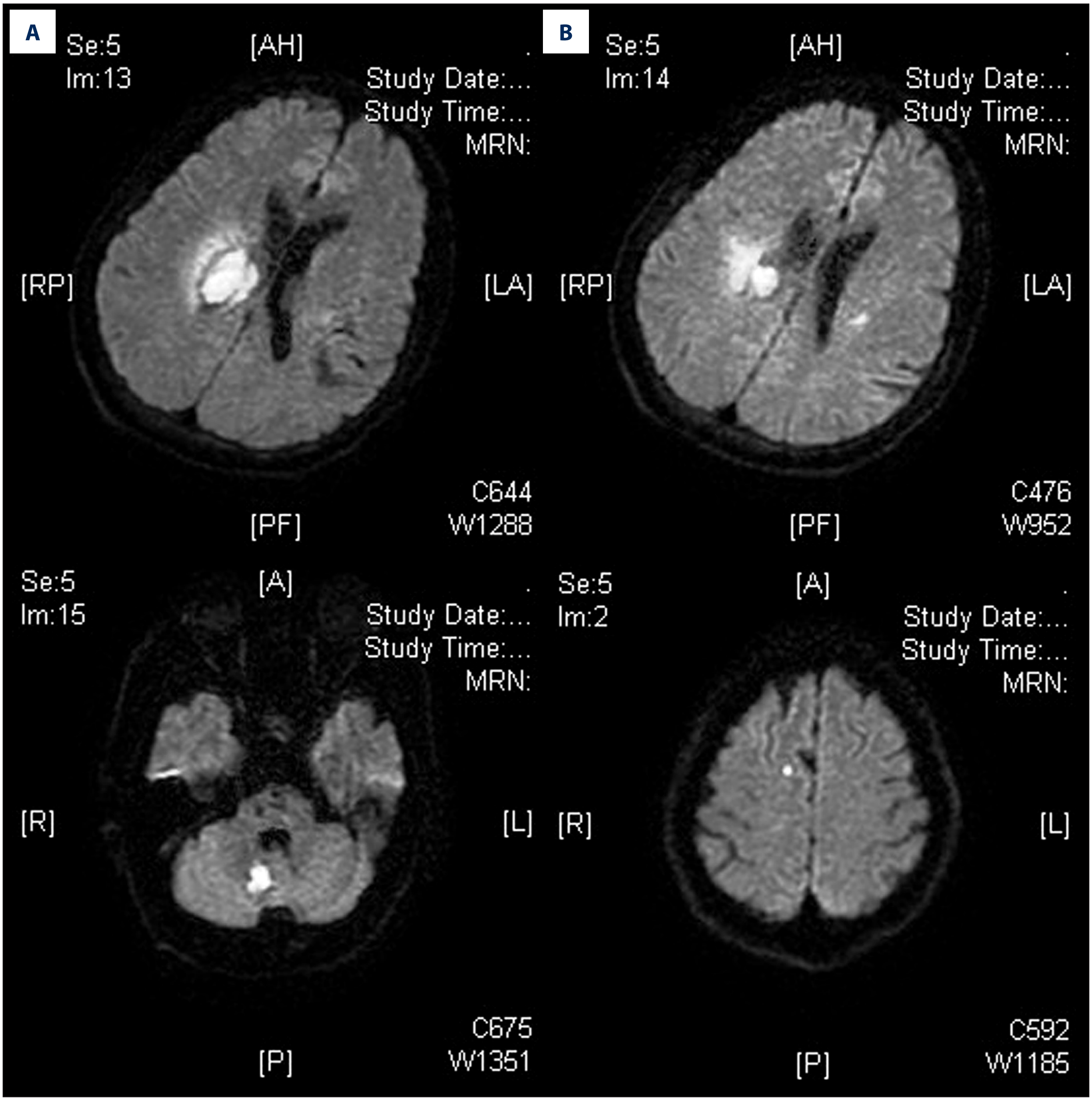

Figure 1. The diffusion-weighted imaging of magnetic resonance imaging (**A** is cerebral bleeds; **B** is silent cerebral infarction).

Follow-up

Patients were followed up by telephone interview. Those who were unable to answer the orientation questions underwent an agent interview. Every 3 months after the stroke, patients were asked to answer standardized follow-up questions. Cases of recurrent stroke were cross-checked with the treating hospitals to ensure the accuracy of diagnosis. In case of suspected stroke recurrence without hospitalization, the case was adjudicated by the trial executive committee. Data collected included stroke recurrence and death caused by recurrent cerebrovascular events. Mortality was defined as death from cerebrovascular events confirmed by either a death certificate from the local citizen registry or records from the treating hospital.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation and were analyzed with the independent-sample *t* test. Categorical data, shown as count and percentage, were analyzed with either the chi-square test or the Fisher's exact test. Ranked ordinal data were analyzed with the Wilcoxon rank sum test. Multivariate logistic regression analysis was used for independent variables with significant significance through

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

single-factor analysis. Two-tailed P values <0.05 were considered statistically significant. All statistical analyses were performed using SPSS version 17.0 (IBM, Armonk, NY).

Results

Risk factors analysis of silent cerebral infarction

Of 152 patients with non-amyloid ICH, 46 (30.26%) were found to have silent cerebral infarction (Figure 1).Compared with patients without silent cerebral infarction, patients with silent cerebral infarction had lower levels of urea nitrogen (P=0.024), higher white blood cell (WBC) counts (P=0.005), more CMBs (P<0.001), more severe leukoaraiosis (P<0.001), and more lacunar infarctions (P=0.003) (Table 1).

Multivariate logistic regression analysis showed that CMBs, WBC counts, and leukoaraiosis were independent risk factors for silent cerebral infarction (Table 2).

Risk factors for recurrence of cerebrovascular events

During the 12-month follow-up, 34 (22.37%) patients had recurrent cerebrovascular events. Among them, 8 died of related cerebrovascular events. During the 12-month follow-up, the recurrence of cerebrovascular events was associated with diabetes, atrial fibrillation, smoking, or alcohol consumption, but was significantly associated with urea nitrogen (P=0.001), CRP (P=0.028), silent cerebral infarction (P<0.001), and leukoaraiosis (P=0.044). Compared with patients without cerebrovascular events, those with cerebrovascular events had higher CRP, lower urea nitrogen, higher incidence of silent cerebral infarction, and more sever leukoaraiosis (Table 3).

Multivariate logistic regression analysis showed that silent cerebral infarction was an independent predictor of clinical cerebrovascular events within 1 year after the onset of ICH. Older patients tended to have higher incidence of cerebrovascular events (Table 4).

Discussion

Silent cerebral infarction can be found not only in patients with cerebral infarction, but also in patients with ICH or subarachnoid hemorrhage [4,6,15]. Prior studies have found that silent cerebral infarction was observed in 13–41% of patients with acute ICH [16,17]. The present study found silent cerebral infarction in 30.26% of patients with non-CAA ICH. As in previous studies, we also found that the presence of 2 MRI markers for small-vessel diseases (SVDs) – including leukoaraiosis and CMBs – are associated with new DWI lesions in non-CAA ICH patients [5,18]. Two types of SVD (arteriopathy and CAA) have been proposed to be associated with deep and lobar ICH, respectively [8].

The pathophysiological mechanism of silent cerebral infarction is related to atherosclerosis and microembolism of arterioles less than 100 μm in diameter, which is a special type of lacunar infarction. In fact, a new DWI lesion has also been recognized as a neuroimaging marker for SVD [19]. Because of the relatively mild degree of ischemia, the short duration of ischemia, or the rapid establishment of good collateral circulation, there is no evidence of transient ischemic attack or cerebral infarction in patients with silent cerebral infarction, leaving only evidence of neuroimaging changes. Cerebral blood flow and brain metabolism in patients with silent cerebral infarction were studied by positron-emission tomography. Cerebral cortex blood flow was decreased slightly and oxygen consumption increased significantly in patients with silent cerebral infarction, suggesting insufficient blood perfusion in local brain tissue. However, examination of cerebral infarction patients with symptoms and signs of neurological impairment showed a consistent decrease in blood flow and oxygen metabolism in the brain [20].

The changes in cerebral blood flow, brain metabolism, and blood-brain barrier and the release of inflammatory factors caused by ICH may be the pathological mechanism of silent cerebral infarction in non-CAA ICH [3,21].

These changes not only cause dysfunction of blood flow regulation and luminal occlusion, but also cause the vessel wall to become disrupted and fragmented, making it prone to blood extravasation and microaneurysm formation [22,23]. Another possible explanation is that the presence of silent cerebral infarction is a more severe vasculopathy that can lead to more CMBs or leukoaraiosis.

To the best of our knowledge, this is the first report on the association of WBC counts with silent cerebral infarction after non-CAA ICH. The CAPRIE trial [24], which included 18 588 patients with ischemic stroke, myocardial infarction, or peripheral vascular disease, found that increased WBC counts, especially neutrophil count, were independent risk factors for recurrent ischemic events in high-risk groups. The study also found that WBC counts started significantly higher than baseline at 1 week before ischemic events, but not earlier. In a prospective cohort study based on multiethnic urban populations, Elkind et al. (2005) found in stroke risk increased by 20% for each additional cell count of 1.8×10^9 cells/L on a baseline basis for 3103 people without stroke with average age of 52 years. Adjusted for other stroke risk factors, other ischemic events also increased. They suggested that elevated levels of WBC relative to baseline were independent risk factors for stroke

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 1. Single risk factors analysis of silent cerebral infarction.

Characteristic	Control (n=106)	Observation (n=46)	t/Z/χ^2-value	P-value
Age (years)	59.70±11.30	60.46±9.01	0.708	0.480
Sex			0.392	0.531
Male	73 (68.87)	34 (73.91)		
Female	33 (31.13)	12 (26.07)		
Coronary heart disease	16 (15.09)	14 (30.43)	0.432	0.511
Hypertension	93 (87.73)	38 (82.61)	1.758	0.415
Diabetes	10 (9.43)	8 (17.39)	1.946	0.163
Smoking	50 (47.17)	23 (50.00)	0.103	0.748
Drinking	48 (45.28)	27 (58.69)	2.309	0.129
Lacunar infarction	25 (23.58)	22 (47.83)	8.825	0.003
Atrial fibrillation	4 (3.77)	2 (4.35)	0.028	0.867
Coronary heart disease	4 (3.77)	4 (8.69)	1.559	0.212
Stroke history	29 (27.36)	7 (15.22)	2.616	0.106
Glucose (mmol/L)	7.09±2.08	6.97±2.22	2.453	0.022
Hematoma volume (mL)	12.21±10.80	11.16±11.14	0.538	0.592
Total protein (g/L)	63.42±8.36	65.32±7.54	1.323	0.188
Albumin (g/L)	38.21±6.11	39.69±5.54	1.403	0.163
Systolic blood pressure (mmHg)	164.45±24.33	170.00±23.77	1.300	0.196
Diastolic blood pressure (mmHg)	97.82±18.06	99.43±12.85	0.625	0.533
NIHSS score at admission	8.85±6.84	8.59±6.95	0.216	0.839
GCS	13.65±2.70	14.04±2.76	0.878	0.381
Total bilirubin (mmol/L)	12.23±5.34	11.11±6.62	1.109	0.269
Direct bilirubin (mmol/L)	2.24±1.18	2.30±1.46	0.242	0.809
Cholesterol (mmol/L)	4.65±0.92	4.51±0.91	0.874	0.384
Triglyceride (mmol/L)	1.67±1.25	1.49±0.92	0.865	0.389
High-density lipoprotein Cholesterol (mmol/L)	1.17±0.29	1.19±0.29	0.525	0.601
Low-density lipoprotein Cholesterol (mmol/L)	2.29±0.63	2.39±0.62	0.866	0.389
Blood urea nitrogen (mmol/L)	5.41±1.66	4.74±1.67	2.281	0.024
Creatinine (mmol/L)	67.71±42.17	63.21±12.35	0.403	0.965
White blood cells (10^9/L)	7.43±1.86	8.40±2.01	2.874	0.005
Red blood cells (10^{12}/L)	4.73±0.55	4.66±0.49	0.734	0.464
Platelets (10^9/L)	208.41±68.69	208.50±52.86	0.008	0.994
Fibrinogen (g/L)	3.18±0.92	3.36±0.89	1.129	0.261
C-reactive protein (mg/L)	5.86±4.85	5.24±3.59	0.781	0.436
Pneumonia	16 (15.09)	12 (26.08)	0.837	0.360
CMBs	38 (35.85)	32 (69.57)	14.678	0.000

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 1 continued. Single risk factors analysis of silent cerebral infarction.

Characteristic	Control (n=106)		Observation (n=46)		t/Z/χ^2-value	P-value
Leukoaraiosis					4.712	0.000
No	47	(44.34)	7	(15.22)		
Mild	41	(38.68)	15	(32.61)		
Moderate	15	(14.15)	16	(34.78)		
Severe	3	(2.83)	8	(17.39)		
Prognosis						
Cerebrovascular event	13	(12.26)	21	(45.65)	20.593	0.000
Death	3	(4.72)	5	(10.87)	4.158	0.041

Values are presented as mean ±deviation or n (%). NIHSS – National Institute of Health Stroke Scale; GCS – Glasgow Coma Score; CMBs – cerebral microbleeds.

Table 2. Multivariate logistic regression analysis of significant risk factors for silent cerebral infarction.

Factor	OR	95% CI	P value
CMBs	3.799	1.294–11.153	0.015
Urea	0.832	0.629–1.100	0.197
White blood cell	1.433	1.122–1.829	0.004
Lacunar infarction	1.917	0.699–5.253	0.206
Leukoaraiosis	1.897	1.032–3.488	0.039

OR – odds ratio; CI – confidence interval; CMBs – cerebral microbleeds.

Table 3. Single risk factor analysis for recurrence of cerebrovascular events.

Characteristic	Recurrence (n=34)		Non-recurrence (n=118)		t/Z/χ^2-value	P-value
Age (years)	64.21±11.28		59.77±10.66		2.109	0.037
Sex					0.392	0.531
Male	26	(68.42)	81	(68.64)	0.776	0.378
Female	8	(23.53)	37	(31.36)		
Coronary heart disease	2	(5.88)	6	(5.08)	0.034	0.856
Hypertension	29	(85.29)	102	(86.44)	1.424	0.491
Diabetes	4	(11.76)	14	(11.86)	0.000	0.987
Smoking	16	(9.89)	57	(9.89)	0.016	0.898
Drinking	16	(47.06)	59	(50.00)	0.091	0.762
Lacunar infarction	11	(32.35)	36	(30.51)	0.042	0.838
Atrial fibrillation	1	(2.94)	5	(4.24)	0.117	0.732
Coronary heart disease	2	(5.88)	6	(5.08)	0.034	0.854
Stroke history	7	(20.59)	29	(24.58)	0.232	0.630

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 3 continued. Single risk factor analysis for recurrence of cerebrovascular events.

Characteristic	Recurrence (n=34)	Non-recurrence (n=118)	t/Z/χ^2-value	P-value
Glucose (mmol/L)	6.72±2.26	7.16±2.08	2.453	0.022
Hematoma volume (mL)	10.31±10.86	12.35±10.38	0.338	0.962
Total protein (g/L)	63.23±8.10	64.20±8.17	0.587	0.558
Albumin (g/L)	39.42±4.96	38.44±6.22	0.840	0.402
Systolic blood pressure (mmHg)	171.50±22.07	164.58±24.68	1.472	0.413
Diastolic blood pressure (mmHg)	101.29±12.93	97.45±17.51	1.402	0.165
NIHSS score at admission	7.53±6.32	9.13±6.99	1.199	0.232
GCS	14.50±1.33	13.56±2.75	1.927	0.056
Total bilirubin (mmol/L)	10.62±6.27	12.26±5.58	1.466	0.145
Direct bilirubin (mmol/L)	2.37±1.51	2.22±1.20	0.591	0.555
Cholesterol (mmol/L)	4.44±0.96	4.65±0.88	1.218	0.225
Triglyceride (mmol/L)	1.52±1.00	1.65±1.21	0.545	0.586
High-density lipoprotein Cholesterol (mmol/L)	1.20±0.30	1.17±0.29	0.530	0.597
Low-density lipoprotein Cholesterol (mmol/L)	2.30±0.65	2.33±0.62	0.185	0.853
Urea (mmol/L)	4.54±1.11	5.42±1.77	3.484	0.001
Creatinine (mmol/L)	60.72±14.77	68.00±39.52	1.052	0.295
Uric acid (mmol/L)	262.47±74.86	274.03±81.54	0.723	0.471
White blood cells (10^9/L)	7.60±2.05	7.75±1.94	0.388	0.698
Red blood cells (10^{12}/L)	4.59±0.58	4.75±0.51	1.525	0.129
Platelets (10^9/L)	205.82±56.70	209.20±65.98	0.270	0.787
Fibrinogen (g/L)	3.09±0.77	3.28±0.95	1.046	0.297
C-reactive protein (mg/L)	4.27±2.49	6.05±4.85	2.884	0.005
Pneumonia	4 (11.76)	24 (20.34)	1.291	0.256
CMBs	18 (52.94)	52 (44.07)	0.837	0.360
Silent cerebral infarction	21 (61.76)	13 (11.07)	20.593	0.000
Leukoaraiosis			2.213	0.044
No	5 (14.71)	41 (34.75)		
Mild	11 (32.35)	44 (37.29)		
Moderate	11 (32.35)	18 (47.06)		
Severe	2 (5.88)	8 (6.78)		

Values are presented as mean ± deviation or n (%). NIHSS – National Institute of Health Stroke Scale; GCS – Glasgow Coma Score; CMBs – cerebral microbleeds.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 4. Multivariate logistic regression analysis of significant risk factors for recurrent cerebrovascular events.

Factor	OR	95%CI	P value
Age	1.071	0.999–1.149	0.055
Silent cerebral infarction	6.792	1.631–28.28	0.008
C-reactive protein	0.854	0.712–1.023	0.086
Urea	0.655	0.363–1.182	0.160
Leukoaraiosis	0.883	0.420–1.856	0.742

OR – odds ratio; CI – confidence interval; CMBs – cerebral microbleeds.

and other cardiovascular events. The results of our study were consistent with those of the above studies. The mechanism of increased risk of stroke or silent cerebral infarction due to increased WBC count is unclear, but it is presumed to be related to the process of atherosclerosis [25].

Logistic regression analysis showed that silent cerebral infarction in non-CAA ICH was an independent predictor of recurrent cerebrovascular events and related deaths during a follow-up period of 12 months. In our study, 22.37% of the patients experienced recurrent cerebrovascular events and related deaths. Kang et al. [3] also found that silent cerebral infarction occurring together with ICH increased the risk of future clinical cerebrovascular events or vascular deaths. Our findings are consistent with theirs. Therefore, a DWI scan after ICH can assess the risk of future clinical cerebrovascular events. Clinicians also need to pay attention to patients with silent cerebral infarction in ICH in order to reduce the incidence of clinical cerebrovascular events and vascular-related deaths.

This study had some limitations. All 152 patients had mild-to-moderate cerebral hemorrhage owing to the exclusion of patients with severe condition or who were undergoing surgery, which may have biased our results. Because of the strict criteria for inclusion into the group, the number of selected patients was relatively small and the follow-up time was short; thus, further studies with more cases and extended follow-up time are needed. Similar research should be carried out in CAA patients. Determining how to reduce the incidence of cardiovascular events in patients with silent cerebral infarction is also a promising research direction.

Conclusions

Silent cerebral infarction can occur in the acute phase of non-CAA ICH and is closely related to WBC counts, CMBs, and leukoaraiosis. A silent cerebral infarction following non-CAA ICH indicates a higher risk of clinical cerebrovascular events in the future.

Acknowledgments

We would like to thank Editage (*www.editage.com*) for English language editing. We also thank Dr. Baoguang Hu for his strong support in the statistical analysis and language editing.

Conflicts of interest

None.

References:

1. van Asch CJ, Luitse MJ, Rinkel GJ et al: Incidence, case fatality, and functional outcome of intracerebral haemorrhage over time, according to age, sex, and ethnic origin: A systematic review and meta-analysis. Lancet Neurol, 2010; 9(2): 167–76
2. Liu L, Wang D, Wong KL, Wang Y: Stroke and stroke care in China: Huge burden, significant workload, and a national priority. Stroke, 2011; 42(12): 3651–54
3. Kang DW, Han MK, Kim HJ et al: New ischemic lesions coexisting with acute intracerebral hemorrhage. Neurology, 2012; 79(9): 848–55
4. Helbok R, Madineni RC, Schmidt MJ et al: Intracerebral monitoring of silent infarcts after subarachnoid hemorrhage. Neurocr Care, 2011; 14(2): 162–67
5. Nolte CH, Albach FN, Heuschmann PU et al: Silent new DWI lesions within the first week after stroke. Cerebrovasc Dis, 2012; 33(3): 248–54
6. Okamoto Y, Ihara M, Tomimoto H: Silent ischemic infarcts are associated with hemorrhage burden in cerebral amyloid angiopathy. Neurology, 2010; 74(1): 93
7. Prabhakaran S, Gupta R, Ouyang B et al: Acute brain infarcts after spontaneous intracerebral hemorrhage: A diffusion-weighted imaging study. Stroke, 2010; 41(1): 89–94
8. Tsai YH, Lee MH, Weng HH et al: Fate of diffusion restricted lesions in acute intracerebral hemorrhage. PLoS One, 2014; 9(8): e105970
9. Linn J, Halpin A, Demaerel P et al: Prevalence of superficial siderosis in patients with cerebral amyloid angiopathy. Neurology, 2010; 74(17): 1346–50
10. Wardlaw JM, Smith C, Dichgans M: Mechanisms of sporadic cerebral small vessel disease: insights from neuroimaging. Lancet Neurol, 2013; 12(5): 483–97
11. Gregg NM, Kim AE, Gurol ME et al: Incidental cerebral microbleeds and cerebral blood flow in elderly individuals. JAMA Neurol, 2015; 72(9): 1021–28
12. Staals J, Booth T, Morris Z et al: Total MRI load of cerebral small vessel disease and cognitive ability in older people. Neurobiol Aging, 2015; 36(10): 2806–11

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

13. Groeschel S, Kehrer C, Engel C et al: Metachromatic leukodystrophy: Natural course of cerebral MRI changes in relation to clinical course. J Inherit Metab Dis, 2011; 34(5): 1095–102
14. Musolino PL, Gong Y, Snyder JM et al: Brain endothelial dysfunction in cerebral adrenoleukodystrophy. Brain, 2015; 138(11): 3206–20
15. Coutts SB, Hill MD, Campos CR et al: Recurrent events in transient ischemic attack and minor stroke: what events are happening and to which patients? Stroke, 2008; 39(9): 2461–66
16. Arsava EM, Kayim-Yildiz O, Oguz KK et al: Elevated admission blood pressure and acute ischemic lesions in spontaneous intracerebral hemorrhage. J Stroke Cerebrovasc Dis, 2013; 22(3): 250–54
17. Gregoire SM, Charidimou A, Gadapa N et al: Acute ischaemic brain lesions in intracerebral haemorrhage: Multicentre cross-sectional magnetic resonance imaging study. Brain, 2011; 134(8): 2376–86
18. Prabhakaran S, Sheth KN: Small ischemic lesions following intracerebral hemorrhage Silent but deadly. Neurology, 2012; 79(9): 838–39
19. Kranz PG, Eastwood JD: Does diffusion-weighted imaging represent the ischemic core? An evidence-based systematic review. Am J Neuroradiol, 2009; 30(6): 1206–12
20. Nakane H, Ibayashi S, Fujii K et al: Cerebral blood flow and metabolism in patients with silent brain infarction: Occult misery perfusion in the cerebral cortex. J Neurol Neurosurg Psychiatry, 1998; 65(3): 317–21
21. Dziedzic T, Bartus S, Klimkowicz A et al: Intracerebral hemorrhage triggers interleukin-6 and interleukin-10 release in blood. Stroke, 2002; 33(9): 2334–35
22. Attems J, Jellinger K, Thal DR, Van Nostrand W: Sporadic cerebral amyloid angiopathy. Neuropathol Applied Neurobiol, 2011; 37(1): 75–93
23. Smith EE, Greenberg SM: β-amyloid, blood vessels, and brain function. Stroke, 2009; 40(7): 2601–6
24. Grau AJ, Boddy AW, Dukovic DA et al: Leukocyte count as an independent predictor of recurrent ischemic events. Stroke, 2004; 35(5): 1147–52
25. Mozos I, Malainer C, Horbańczuk J et al: Inflammatory markers for arterial stiffness in cardiovascular diseases. Front Immunol, 2017; 8: 1058

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]