# Clinical application of magnetic susceptibility weighted imaging in treatment of collateral circulation of cerebral infarction.

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## Abstract

**Objective:** To investigate and discuss the clinical value of Susceptibility Weighted Imaging (SWI) in treatment of the collateral circulation of cerebral infarction.

**Methods:** From January 2015 December 2016, a total of 120 cases of cerebral infarction patients confirmed by the clinical and imaging diagnosis as the research objects. All patients received cranial magnetic susceptibility weighted imaging followed by the observation of brain imaging as well as vascular collateral circulation and SWI corrected phase values were compared between the patients with different degree of collateral vessels. Patients were divided into acute stage, subacute stage and stable recovery stage according to progression disease and the collateral circulation and NIHSS score was compared among the patients with different stages of progression with the correlation coefficients in between determined by way of Pearson correlation coefficient analysis.

**Results:** Among 120 cerebral infarction patients, there were 85 cases of patients, whose SWI images showed collateral vessels, accounting for 70.83%, including 46 cases of level 1 and 39 cases of level 2. The SWI images of remaining 35 cases did not show the collateral vessels, described as level 0 and there was significant difference in SWI corrected phase values between the patients with different degree of collateral vessels. The display rate of collateral vessels was highest firstly in the patients at acute stage, then in those at subacute stage and finally in those at stable recovery stage with the NIHSS scores from high to low respectively as acute stage, subacute stage and stable recovery stage; The analysis result of Pearson correlation coefficient showed the degree of collateral circulation vascular display was negatively correlated with the NIHSS score in the patients with cerebral infarction.

**Conclusion:** Magnetic susceptibility weighted imaging can accurately display the collateral circulation of the patients with cerebral infarction and can be used for the evaluation of curative effects and prognostic evaluation in treatment of the patients with cerebral infarction.

## Introduction

The key to the treatment of patients with cerebral infarction is to establish collateral circulation. The earlier the collateral vessels develop, the faster the cerebral perfusion recovers, which can restore the function of damaged brain tissues in the ischemic penumbra region. Therefore, it is required to make early and accurate judgment on the establishment of collateral circulation of patients with cerebral infarction the clinical to guide clinical treatment [1-3]. Susceptibility Weighted Imaging (SWI) is a new type of imaging technology, enabling to clearly display micro hemorrhage and small vein structure through enhanced contrast of tissue magnetic susceptibility [4,5]. The purpose of this study is to investigate the clinical value of SWI in the case of cerebral infarction by selecting 120 cases of cerebral infarction patients confirmed by the clinical and imaging diagnosis from January 2015 to December 2016 as the research objects shown as follows.

## Materials and Methods

From January 2015 to December 2016, 120 cases of cerebral infarction patients confirmed by the clinical and imaging diagnosis of CT or MRI were selected as the objects in which there were 63 males and 57 females, aged from 51-73, 62.15 ± 9.62 y old on average, including 49 cases in acute stage, 37 cases in subacute phase and 34 cases in stable recovery stage. All patients were informed and volunteered to participate in the study which was approved by the hospital ethics committee in advance.

### Methods

All patients received magnetic susceptibility weighted imaging of head through Verio 3.0 magnetic resonance scanner produced in Siemens with the equipment of 8 channel head coil. The first step was to conduct routine MRI scan, including the scanning of SE sequence on the prospective of cross

section, coronal section and vertical plane with T1WI sequence parameter as TE 40-60 ms, TR 400-500 ms, T2WI sequence parameter as TE 60-80 ms, TR 3000-3500 ms and FLAIR sequence parameter as TE 135 ms, TR 8500 ms and flip angle of 180º. The layer thickness was set as 10 mm with the spacing as 5.0 cm; Next, then SWI scanning was performed by high resolution three-dimensional interference gradient echo sequence with the parameter of TE 25 ms, TR 40 ms, a flip angle of 20º, 0.71 in number of excitation, matrix of 512 × 384 and spatial resolution of 0.47 mm × 0.63 mm × 2.00 mm. The image was transferred to the workstation followed by the processing through the smallest density projection method, phase mask multiplication and high throughput hamming window filter to obtain SWI correction phase diagram and then collateral circulation vessels of cerebral infarction on SWI minimum density projection were observed and measured with SPIN software.

### Observation index

Collateral circulation vessels of the patients with cerebral infarction were observed according to the head image. The SWI corrected phase values of collateral circulation vessels of different display degree was compared. According to the progression disease, the patients were divided into acute stage (<1 d), subacute stage (1-7 d) and stable recovery stage (>7 d). The collateral circulation and NIHSS score was compared among the patients with different stages of progression with the correlation coefficients in between determined by way of Pearson correlation coefficient analysis. The grading standard of collateral vessels display [6]: level 0: no collateral vessels; level 1: collateral vessels did not completely cover the cerebral infarction area with the display; level 2: collateral vessels covered the entire area of cerebral infarction with the display. The NIHSS score, namely the score of neurological impairment, was evaluated by the National Institutes of Health Stroke Scale with a total score of 0-42. The higher the score, the worse the neurological deficit [7].

### Statistical analysis

With SPSS19.0, the counting data were expressed as percentage and examined with Chi-square test. The measurement data were described as mean ± standard deviation and examined with t test to compare the data between 2 groups. F-test was used to compare the data among 3 groups. P<0.05 suggests that the difference is statistically significant. Pearson correlation coefficient analysis was carried out to determine the correlation between different factors.

## Results

### Collateral vessels display of patients with cerebral infarction

Among 120 cerebral infarction patients, there were 85 cases of patients, whose SWI images showed collateral vessels, accounting for 70.83%, including 46 cases of level 1 and 39

cases of level 2. The SWI images of remaining 35 cases did not show the collateral vessels, described as level 0.

### Comparison of SWI corrected phase values in patients with different display degree of collateral vessels

There was statistical difference in SWI corrected phase values of patients with different display degree of collateral vessels (Table 1).

*Table 1. Comparison of SWI corrected phase values in patients with different display degree of collateral vessels.*

| Display degree | Case | SWI corrected phase value |
|---|---|---|
| Level 0 | 35 | 0.138 ± 0.025 |
| Level 1 | 46 | 0.106 ± 0.023 |
| Level 2 | 39 | 0.084 ± 0.020 |
| F | - | 5.679 |
| P | - | 0.009 |

### Comparison of collateral circulation display rate and NIHSS score of the patients at different stage of disease progression

The display rate of collateral vessels was highest firstly in the patients at acute stage, then in those at subacute stage and finally in those at stable recovery stage with the NIHSS scores from high to low respectively as acute stage, subacute stage and stable recovery stage (Table 2).

*Table 2. Comparison of collateral circulation display rate and NIHSS score of the patients at different stage of disease progression.*

| Stage | Case | Display rate | NIHSS score |
|---|---|---|---|
| Acute stage | 49 | 27 (55.10%) | 16.93 ± 3.89 |
| Subacute stage | 37 | 26 (70.27%) | 12.54 ± 2.67 |
| Stable recovery stage | 34 | 32 (94.12%) | 10.05 ± 2.16 |
| Total | - | 6.718 | 7.163 |
| P | - | 0.010 | 0.007 |

### Correlation analysis

According to Pearson correlation coefficient analysis, the display degree of collateral circulation showed a closely negative correlation with the NIHSS score in the patients with cerebral infarction (Table 3).

*Table 3. Correlation analysis.*

| Variable | NIHSS score | |
|---|---|---|
| | r | P |
| Display rate of collateral circulation | -0.816 | 0.001 |

| | | |
|---|---|---|
| Display degree of collateral circulation | -0.809 | 0.002 |

## Discussion

Cerebral infarction is a common disease in neurology and mainly refers to cerebral ischemia and hypoxia as well as impaired nerve function caused by inadequate blood supply in the brain. It is also known as the "stroke" with sudden morbidity and rapid progression. It has high morbidity and mortality and the patient would probably die due to insufficient cerebral blood supply or the failure of timely treatment, which poses a serious threat to the patients' life safety, thus making it essential to take active treatment of cerebral infarction to reduce the death in clinical trials [8-12].

The main objective of the clinical treatment for cerebral infarction is to develop collateral circulation and the early establishment of collateral vessels enables to form reperfusion in focal cerebral ischemia, which helps to save ischemic penumbra by facilitating the effective repair of its brain tissue function. As a result, It is of much significance to monitor the established collateral vessels of cerebral infarction patients in clinical practices [13-15]. According to this study, the display rate of collateral vessels was highest firstly in the patients at acute stage, then in those at subacute stage and finally in those at stable recovery stage with the NIHSS scores from high to low respectively as acute stage, subacute stage and stable recovery stage; The analysis result of Pearson correlation coefficient showed the degree of collateral circulation vascular display was negatively correlated with the NIHSS score in the patients with cerebral infarction, suggesting that we can, in a certain extent, tell the disease progression and neurological function of the patients with cerebral infarction through the monitoring of the collateral circulation vessels.

Magnetic resonance imaging is the main means to the diagnosis of cerebral infarction and it mainly refers to conducting multi-sequence scan on the sites of brain tissue lesions in the principle of magnetic resonance and in this way to gain electromagnetic signals of the brain tissues and complete its reconstruction of information. It has moderately high resolution of soft tissues and is able to clearly display vascular structure with no radiation, safe and reliable [16,17]. Susceptibility weighted imaging, a new type of magnetic resonance imaging technology, mainly means obtaining the phase diagram by use of magnetic susceptibility differences between the groups and reaching corrected phase image by filtering to clearly show the formation of brain microvascular [18-20]. The study found there was significant difference in SWI corrected phase value between the patients with different display degree of collateral vessels of statistical significance (P<0.05), illustrating that SWI technology can clearly demonstrate and reflect the formation of collateral vessels in the patients with cerebral infarction.

To sum up, magnetic susceptibility weighted imaging can accurately display the collateral circulation of the patients with cerebral infarction and can be used for the evaluation of curative effects and prognostic evaluation in treatment of the patients with cerebral infarction.

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