

CT Blend Signs are not Associated with Poor Outcome in Patients with ICH Following a Stereotactic Minimally Invasive Surgery

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Abstract

Backgrounds: The initial CT blend sign has been used as an imaging maker to predict haematoma expansion and poor outcome in patients with small volume intracerebral haemorrhage (ICH). However, the relationship between the blend sign and the outcome of patients remains elusive. The present study aimed to retrospectively observe the impact of initial CT blend signs on the short-term outcome of patients with hypertensive ICH underwent a stereotatic minimally invasive surgery (sMIS).

Methods: Two hundreds and forty-two patients with spontaneous ICH were enrolled. Based on the initial CT features, the patients were assigned to a blend sign group (including 91 patients) or a non-blend sign group (control group, including 151 patients). The NIHSS, GCS and the mRS were used to observe the efficacy of the sMIS. The rates of severe pulmonary infection, cardiac complications were also compared between the two groups.

Results: No significant differences in NIHSS and GCS in one week or two weeks after surgery were observed between the two groups. The proportion of patients with good outcome during follow-up did not show any difference between the two groups. However, both the two groups displayed good functional outcome over admission. The rate of rehaemorrhage increased in the blend sign group. No significant differences in severe pulmonary infections and cardiac complications were noted between the two groups.

Conclusions: The initial CT blend sign are not associated with poor outcome of patients with hypertensive ICH underwent sMIS. ICH patients with CT blend sign should be also treated by performing sMIS if they are candidates for surgery.

1 Background

Spontaneous ICH remains a devastating life-threatening disease with high mortality and morbidity worldwide. To improve the outcome of the patients with ICH, various clinical medical and surgical trials for interventions of the ICH have been conducted in recent 10 years¹. However, although research and trials of therapies for ICH have been increased greatly, the 30-day mortality remains as high as more than 40% 30-day all over the world². And no interventional therapy has been demonstrated to be effective in improving outcomes³. Open craniotomy haematoma evacuation in large clinical randomized trials have not showed benefits for patients with ICH⁴. Although craniotomy showed effectiveness in removing the ICH, it resulted in remarkable brain injury and complicated with pulmonary infection⁴. Advantages of conventional surgical management over conservative medications of hypertensive ICH have been controversial⁵. Patients with supratentorial ICH showed no overall benefit from early neurosurgical management as compared to initial conservative treatment⁶. Brain injury due to conventional surgical procedures of ICH might counteract the potential benefits of haematoma removal during open surgery⁷. Recently, the MIS for ICH management has been evaluated in numerous clinical trials and has achieved favorable results⁸⁻¹⁰. Minimally invasive puncture and drainage was the least traumatic procedure and

had the shortest operative time⁴. Although, for moderate to large ICH, minimally invasive catheter evacuation followed by thrombolysis did not improve the proportion of patients who achieved a good response, the haematoma size reduction to 15 ml or less was associated with improved mRS scores at 365 days in patients who were stabilized⁴.

Haematoma expansion(HE) or haematoma growth predicts strongly worse prognosis and might be potentially preventable if high-risk patients could be identified in the early stage of ICH². Several imaging markers, such as the blend signs, the black hole signs and the spot sign have been identified to predict the HE^{2, 11-13}. The blend sign showed association with poor outcome in patients with small volume of ICH treated by medications². Our previously studies showed that the black hole sign and the blend sign predicted rehaemorrhage in patients with hypertensive ICH underwent stereotactic minimally invasive surgery(sMIS)^{14, 15}. However, whether the initial CT blend signs are associated with poor outcome in patients following sMIS is unknown. As the initial CT blend signs were associated with poor outcome of patients receiving medications and rehaemorrhage in patients following minimally invasive surgery. So we speculated that the initial CT blend sign was associated with poor outcome in patients with ICH receiving sMIS. The present study aimed to retrospectively observe the influences of the initial CT blend sign on the outcome of patients with spontaneous ICH following sMIS.

2 Methods

The Ethics Committee of the Affiliated Hospital of Guizhou Medical University approved this retrospective study. The study was performed based on the WMA Declaration of Helsinki. Patients with ICH admitted to our hospital and underwent sMIS were included in our study. The recruitment period was from January 1, 2018 to June 30, 2019.

2.1 Study design and participants

2.1.1 Study design

A retrospective analysis was performed in the present study. The authors aimed to determine whether initial CT blend signs are associated with poor functional outcome of patients with ICH following sMIS. We collected data from patients with ICH by reviewing the medical records of the Affiliated Hospital of Guizhou Medical University. The recruitment period was from January 1, 2018 to June 30, 2019. The patients were diagnosed by a baseline CT scan within 1 hour of admission, and the surgery was performed within 24 hours after admission. The eligible patients with ICH were selected by the inclusion criteria below. All eligible patients were treated by sMIS and were assigned to two groups based on their haematoma features.

The inclusion criteria were as follows: (1) Patients (over 18 years old) with a history of hypertension or hypertension observed upon admission, and the symptoms and signs met the diagnostic criteria for ICH, which was confirmed by a non-enhanced CT scan. (2) Patients suffered from spontaneous ICH in the

basal ganglia and thalamus. (3) Patients with the ICH volume between 30 ml and 50 ml. (4) Patients were candidates without contraindications for surgery. (4) Authorized representatives of the patients provided consent for the surgery.

The exclusion criteria were the same as previously published studies¹⁵. Patients with ICH located in the brainstem or with secondary ICH from haemorrhagic transformation from brain infarction were not included. Patient without an authorized representative consent to surgery were also excluded from the study.

2.1.2 Participants

From January 1, 2018 to June 30, 2019, a total of 710 patients with spontaneous ICH were admitted to the Affiliated Hospital of Guizhou Medical University. Among them, 318 patients received sMIS. Of the 318 patients that underwent sMIS, 25 patients left the hospital in one week without medical orders, and 21 patients with ICH located in the brainstem, another 30 patients with large volume (over 50 mL) ICH. These 76 patients were not included in the final analysis (Fig.1).

Based on the inclusion criteria, 242 sequential patients with spontaneous ICH were included in the present study. All the patients received a sMIS. The patients were assigned to the following groups based on their CT haematoma features. The blend sign group included 91 patients and the non-blend sign group (control group) included 151 patients with spontaneous ICH. The baseline clinical characteristics of patients were listed in Table 1. The blend sign group showed higher rate of hypertension history ($P=0.004$) and gender (male, $P=0.027$) over the control group. There were not statistic differences in age, hypertension, diabetes mellitus, smoking, and alcoholic drinking between the blend sign group and the control group.

2.2 Imaging analysis

The initial CT and follow-up CT scans (General Electric Medical Systems, Milwaukee,WI) were performed using standard clinical parameters with axial 3-mm-thick sections, current of 225 mA, window level of 39 and window width of 120. The images were obtained and stored for further evaluation. The ICH for each patient was located in the basal ganglia and thalamus. Two experienced experts (one neurosurgical and one neuroimaging experts) blinded to the clinical information of the patients served as reviewers and independently evaluated the shape features of the haematoma. The shape of the haematoma was assessed by visual inspection¹⁶. The blend sign was determined by the criteria proposed in previously published studies¹⁷. Discrepancies about the presence of the blend signs were settled by joint discussion between the readers.

Haematoma volumes were estimated based on CT using the ABC/2 formula ($t=\pi/6 \times l \times s \times \text{slice}$)¹⁸. The criteria for identify the blend sign was the same as those reported in the literature¹⁵. The blend sign was composed of two parts with different densities on CT (Fig.2)

2.3 Treatment of patients

2.3.1 sMIS for ICH evacuation

The sMIS for the ICH evacuation was the same procedure that was used in our previously published studies^{19,22,23}. In order to remove the influences of the surgical technical factors on the outcomes, the surgical procedures were performed by two experienced neurosurgeons. Briefly, a stereotactic instrument was fixed on the patient's skull and a repeated CT scan was performed for each patient prior to surgery. After the repeating CT scan was performed, the patient was transferred to the operating room. Using the CT scan, the coordinates of the ICH was figured out and we punctured the skull by using a 3-mm-diameter needle (with a drill integrated into the needle guard) under the guidance of the stereotactic instrument. After the drill was replaced by a tip-blunt plastic-needle core, the LY-1-type puncture-needle set was inserted slightly into the haematoma. Following removal of the plastic-needle core, the liquid part of the haematoma was aspirated with a 10-ml syringe. The aspiration was stopped after first resistance was encountered, and the needle guard connected to a plastic tube was retained for several days for drainage. The patients were transferred to the intensive care unit after removing the location framework and stereotactic apparatus. Then, 50,000 units (diluted in 2 ml of normal saline) of urokinase were injected slowly every 8 hours into the residual haematoma area to dissolve the solid part of the haematoma. The needle system was closed for 2 hours before reopening to allow spontaneous drainage. The first postoperative follow-up CT scan was performed on following day after surgery and the second postoperative CT was performed on the third day after surgery. Some patients needed a third or even a fourth postoperative follow-up CT scan. If the patients showed neurological deterioration after surgery, a repeated CT scan was performed at any time.

2.3.2 Medications

All patients in our study received the same medical management based on the guidelines for the treatment of hypertensive ICH¹⁹. In addition, more comprehensive measures were also taken in all patients, including the prevention of deep-venous thrombosis (DVT), the control of temperature and blood glucose, nutritional support, and the prevention of other complications. The main measures for preventing DVT were to move slowly the paralysed limbs and to wear socks. No anticoagulants were used to prevent DVT during the hospital stay because they might induce haemorrhage.

2.4 Efficacy outcome

The primary efficacy outcomes were functional good outcome, defined as the proportion of patients who achieved a modified Ranking Scale (mRS) score of 0–3 in at discharge. The secondary outcomes included the National Institutes of Health Stroke Scale (NIHSS) scores, the Glasgow Coma Scale (GCS) scores and the ICH volume changes. The outcome was considered favourable if the mRS score was 0–3 points. In contrast, if the mRS score was >3 points, the outcome was considered poor⁴. The GCS and the NIHSS scores were assessed on admission and at one week and two weeks after surgery by experienced

neurological experts. The mortality and complications were recorded during the hospital stay and were compared between the two groups.

2.5.2 Cardiopulmonary complications

Some patients suffered from life-threatening complications during their hospital stay. Severe cardiopulmonary complications mainly included severe pulmonary infection, respiratory failure, or heart failure. The cardiopulmonary complications included were those that occurred in their hospital stay. The exacerbation of chronic heart failure and respiratory failure, as well as community-acquired pneumonia, was not included.

2.6 Statistical analysis

On the basis of the assumption that 38% of patients with ICH would have a mRS score of 0–3 following sMIS⁴, we estimated that 180 patients would provide 95% statistical power at an α level of 0.05. The permissible error d was 0.1, and the design deficiency (deff) was 2. The sample size was calculated using

$$N = \frac{z_{\alpha}^2 p(1 - p)}{\delta^2}$$

the following formula:

A commercially available software package (SPSS, Version 22.0) was used to perform the statistical analyses. Categorical data are shown as proportions, and continuous variables are presented as $\bar{x} \pm S$. Demographic, clinical, and radiological characteristics were compared between patients with shape-regular or shape-irregular ICH using Student's t tests (for normal distribution) or a non-parametric test (if the data were not normally distributed). A difference in the GCS and NIHSS scores between different time points was analysed by the method of repeated measures. A p value less than 0.05 was considered to indicate a statistically significant difference. The independent association between the initial CT blend sign and the outcome of patients after sMIS was evaluated using multivariable logistic regression. The interobserver reliability of CT blend sign was assessed by calculating the κ values. The κ values were categorized as reported in the literature¹⁵. When the κ value is equal to 1, it indicates total agreement between the observers.

3 Results

3.1 The baseline data

During recruitment of period, 318 patients were assessed for eligibility. Out of the 318 patients, 242 patients with ICH met our inclusion criteria. One hundred eighty patients were male, and 69 were female. The ages ranged from 31 to 93 years, with an average of 57.05 ± 12.703 . The time from onset to baseline CT was 5.0 (2.0-9.7) hours. The admission GCS score was $10.62 \pm 5.903/11$ (8-13), and the NIHSS score was $17.02 \pm 5.544/16$ (14-20). One hundred eighty-four patients showed haemaotma in basal ganglia area, 34 patients in cerebral lobes, and 24 patients in thalamus.

Based on their haematoma features, the 242 included patients with ICH were assigned to the above-mentioned two study groups. No significant differences were noted between the blend sign group and the control group in age, history of smoking, drinking, preoperative ICH volume, anticoagulants, GCS score on admission, NIHSS score on admission, time from onset to baseline CT, time from onset to surgery, etc. However, the blend sign group showed higher rate of hypertension history (Table 1).

Discrepancies were noted in 3 patients between the neurosurgeon and the radiologist. The interobserver agreement for identifying the shape features of the haematoma was good and reliable between the 2 readers with a κ value of 0.974

3.2 Changes in haematoma volume

Compared with the control group, the blend sign group did not show significant changes of the ICH volume and the time for removing the drainage tube. The rate of ICH clearance between the blend sign group and the non-blend sign group was also similar. No significant difference was observed between the two groups (Fig.3, Table2). These findings demonstrated that the blend sign did not affect the removal of ICH by the sMIS.

3.3 Changes of the GCS and the NIHSS

The GCS and the NIHSS were determined at one and two weeks after surgery. The blend sign group and the control group showed significantly increased GCS and decreased NIHSS at one and two weeks after surgery as compared with those on admission (Table 3 and Table 4). However, no statistical difference was observed between the two groups. These findings suggested that the patients with the blend sign on initial CT would obtain the same short-term outcome as the non-blend sign patients after sMIS.

3.4 Complications

The blend sign group showed a similar rate of severe complications including the pulmonary infection, heart failure as compared with the control group ($P>0.05$, Table5). However, the blend sign group showed a higher rate of rehaemorrhage over the control group ($P=0.049$).

3.5 Influences of the CT blend sign on the outcome following sMIS

In the 91 patients with CT blend sign, 50 (54.9%) patients showed good outcomes. In 151 patients without blend sign, 71 (51.8%) patients showed good outcomes. No significant differences between the two groups were observed. In 128 patients with good outcome, 50 (39.1%) patients had blend sign on initial CT scan. To determine whether the CT blend signs are associated with poor outcomes, we performed a univariate analysis first and then conducted a binary logistic regression. The history of hypertension ($P=0.037$), NIHSS score on admission ($P=0.000$), GCS score on admission ($P=0.000$) showed statistical significance (Table 6). The blend sign showed no statistical significance with the poor outcome. However, the NIHSS score and the GCS score were also outcome indexes, therefore they were excluded from the final analysis. Therefore, only the history of hypertension went into the model of binary

logistic regression. The final results did not suggest that the hypertension history was an independent predictor of poor functional outcome in patients with ICH following sMIS.

4 Discussions

The spontaneous ICH is the most intractable hemorrhagic stroke. The incidence of the ICH amounts to about 10%-30% of in all types of stroke worldwide. HE predicts strongly worse outcome and is potentially preventable if high-risk patients could be identified in the early stage of ICH¹¹. The initial CT blend sign could predict HE and was associated poor outcome of patients with small volume of ICH receiving medication managements²⁰. The blend signs also showed close association with postoperative rebleeding in patients with ICH following sMIS¹⁵.

The minimally invasive procedures have been used in the management of patients with ICH for more than ten years. It could remove the ICH with less traumatic brain injury and was beneficial for neurofunctional recovery^{21,22}. Minimally invasive catheter aspiration of ICH followed by medications for dissolving the clot could be another choice of surgical approach as a therapeutic strategy for ICH⁹. Minimally invasive puncture and drainage showed the least trauma to the brain and had the shortest operative time⁴. Our previously published studies demonstrated that the initial CT blend signs showed close association with post-operative rehaemorrhage in ICH patients following sMIS¹⁵. So we postulated that the blend signs could affect the outcome of patients with ICH following sMIS. In the present study, the GCS, NIHSS, mRS and postoperative complications were used as indexes to evaluate the outcome. However, the authors were unable to obtain the expected results. The GCS increased and the NIHSS decreased significantly at two weeks after surgery compared with those on admission. But there were no significant differences between the blend sign group and the control group. The proportion of patients with favorable outcome was compared between the patients with blend sign and the control subjects, no significant difference was observed. Secondary complications after ICH could worsen the outcome and are associated with the prognosis^{23,24}. Pneumonia was the most common medical complication(15.1%) after ICH²⁵. Cardio-complications (5.9%) are also easily to occur after ICH due to increased neuroendocrine changes, such as changes in catecholamine levels, elevated levels of brain natriuretic peptide.

In the present study, the patients with the blend signs following the sMIS had similar rates of severe pulmonary infection and heart failure compared with those without the blend signs. No statistical difference was observed between the two groups, suggesting that the patients with the blend signs were not associated with the rate of the complications following the sMIS. The blend sign group showed higher rate of postoperative rehaemorrhage as our previously published study¹⁵. Although the blend signs predicted poor outcome in patients with small volume of ICH, no evidences demonstrate that the blend signs were associated with poor outcome in patients following sMIS. The sMIS should be performed to treat the patients with blend signs on initial CT scan if the ICH volume is large enough and the patients are suitable for surgery.

In conclusions, the sMIS could evacuate the haematoma effectively. The initial CT blend sign was not associated with poor outcome of patients with ICH following sMIS. So ICH patients with CT blend sign should be also treated by performing sMIS if the patients are candidates for surgery.

However, there were some limitations of the present study. The patients were not followed up after discharges, so we were unable to observe the long-term outcomes. Some patients discharged from the hospital without medical orders, the mortality could not be recorded and compared as no deaths happened during hospital stay. The present study was retrospective, further randomized prospective studies with larger sample size are required in the future.

Abbreviations

ICH: intracerebral haemorrhage; CT: computed tomography; sMIS: stereotactic minimally invasive surgery; GCS: Glasgow coma scale; NIHSS: national institute of health stroke scale

Declarations

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Consent for publication

Not Applicable.

Competing of interest

The authors declare that they have no competing interests.

Authors' Contributions

Guofeng Wu and Jingbiao Luo conceived the study, participated in the design of the study, coordinated the study and drafted the manuscript. Linshan Zhang, Yinhui Li and Yuanhong Mao conducted the

clinical study. Likun Wang performed the statistical analyses and drafted the manuscript. All the authors read and approved the final manuscript.

Availability of data and materials statement

The datasets obtained during and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

All the patients' authorized representatives and those patients who had the ability to communicate with the doctors agreed to participate the study. The informed consent was obtained in written form.

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Tables

Table1. Baseline data between blend sign group and control group

Factors	Blend sign group(91)	Control group (151)	χ^2/Z	P-value
Ages years, $x \pm$	56.18 \pm 12.61	57.58 \pm 12.77	-0.814	0.416
Gender male %	73 80.2%	107 70.9%	2.610	0.106
History of smoking n, %	46 50.5%	75 49.7%	0.018	0.500
History of drinking n, %	41 45.1%	67 46.9%	0.1072	0.447
History of hypertension n, %	68 74.7%	110 56.7%	8.582	0.004
Anticoagulants n, %	2 2.2%	4 2.6%	0.048	0.594
History of diabetes n %	2 2.2%	10 6.4%	2.177	0.119
Haematoma volume ml, IQR	37.8(33-52.5)	38(31-50)	-0.879	0.379
Systolic pressure mmHg, $x \pm$	174.03 \pm 24.96	173.33 \pm 29.53	-0.190	0.844
Diastolic pressure mmHg, $x \pm$	103.75 \pm 15.67	100.63 \pm 21.70	1.292	0.198
GCS on admission points, IQR	11 8-13	11 7-13	-0.550	0.583
NIHSS on admission points, IQR	16 14-19	14 16-21	-1.029	0.304
Time for baseline CT h, IQR	21 2-77	2.5 0.5-147	-7.728	0.000
Time from onset to surgery h, IQR	15 9-27	15 9.8-27	-0.728	0.466
Duration of surgery h, IQR	1.4 1.0-1.9	1.5 1.0-2.0	-1.513	0.130
Time for removing the tube days IQR	4(2-6)	4 3-6	-0.121	0.904
Good outcome (n, %)	50 54.9%	78 51.7%	0.247	0.619
Poor outcome (n, %)	41 45.1%	73 48.3%	0.247	0.619
GCS=Glasgow Coma Scale; NIHSS=National Institute of Health Stroke Scale				

Table 2. Changes of residual haematoma volume and rate of ICH clearance during surgery

Group	Preoperative ICH volume [ml, IQR]	Postoperative Residual ICH volume [ml, IQR]	Rate of ICH clearance during surgery [%], IQR	Time for removing the tube [days, IQR]
blend group [n=91]	37.8(33-52.5)	8[3.87-15]	30.61[8.67-56.67]	4[2-6]
Control group [n=151]	38.0(31-50)	8[4.5-12]	37.27[18.98-55.69]	4[3-6]
Z/P-value	-0.879[0.379]	-0.456[0.648]	-0.241(0.809)	-1.121[0.904]

Table 3. Changes of GCS between the blend sign group and control group [IQR]

Group	On admission	One week	Two weeks	χ^2 /P-value
blend sign group [n=91]	11[8-13]	12[9-13]*	13[12-15]&	8.627(0.013)
control group [n=151]	11[7-13]	12[8-14]*	13[9-15]&	22.974(0.000)
Z/P-value	-1.029[0.304]	-0.239[0.811]	-1.136[0.256]	
*Compared with those on admission [P<0.05]. &Compared with the one week [P<0.05].				

Table 4. Changes of NIHSS between the blend sign group and the control group [IQR]

Group	On admission	One week	Two weeks	F/P-value
Blend sign group (n=91)	16[14-20]	13[9-17]\$	10[6-13]&\$	81.475(0.000)
control group [n=151]	16[13-20]	14[10-18]\$	12[8-15]&\$	99.987(0.000)
Z/P-value	-2.075[0.381]	-1.537[0.124]	-0.654[0.513]	
§Compared with those on admission [P<0.05]. &Compared with the control group [P<0.05].				

Table 5 .Comparison of severe complication rate(n,%)

Group	Pulmonary infection	Heart failure	Postoperative rehaemorrhage	good outcome
Blend sign group(n=91)	19(20.9%)	2(2.2%)	23(25.6) &	50(54.9%)
control group (n=151)	30(19.87%)	7(4.6%)	23(15.2)	78 (51.7%)
χ^2 P-value	0.036(0.850)	0.943 (0.275)	3.892(0.049)	0.247 (0.358)
&Compared with the control group(P<0.05);				

Table 6. Univariate analysis of predictors for poor outcome of patients underwent sMIS

Factors	Good outcome (128 patients)	Poor outcome(114 patients)	Z/T	P-value
Ages $\bar{x} \pm \bar{s}$	55.91 \pm 12.55	58.43 \pm 12.81	1.493	0.137
Gender \bar{n} male %	96 \bar{n} 75.0%	84 \bar{n} 73.7%	0.055	0.815
History of smoking \bar{n} , %	63 \bar{n} 49.2%	57 \bar{n} 50.4%	0.0363	0.850
History of drinking \bar{n} , %	51 \bar{n} 39.8%	57 \bar{n} 50.0%	2.517	0.113
History of hypertension \bar{n} , %	87 \bar{n} 68.0%	91 \bar{n} 79.8%	4.357	0.037
Anticoagulants \bar{n} , %	3 \bar{n} 2.3%	4 \bar{n} 3.5%	0.291	0.589
History of diabetes \bar{n} %	4 \bar{n} 3.1%	9 \bar{n} 7.9%	2.699	0.100
Systolic pressure \bar{m} mmHg, $\bar{x} \pm \bar{s}$	171.17 \pm 26.557	176.32 \pm 29.113	1.437	0.152
Diastolic pressure \bar{m} mmHg, $\bar{x} \pm \bar{s}$	101.07 \pm 19.733	102.62 \pm 19.676	0.612	0.541
GCS on admission \bar{n} points, IQR	12(10-13.75)	9(6-12))	-3.672	0.000
NIHSS on admission \bar{n} points, IQR	16(13-18)	17(15-22)	4.105	0.000
Time for baseline CT (hour, IQR)	5.0(2.0-9.9)	4.55(2.0-9.7)	0.301	0.764
ICH volume on admission \bar{m} ml, IQR	36(32-50)	40(30.75-52.39)	0.120	0.2904
Haematoma ruptured into ventricles \bar{n} , %	43 \bar{n} 33.6%	47 \bar{n} 41.2%	1.504	0.220
Time from onset to surgery \bar{h} , IQR	16(8.13-26.75)	13.5(10-27)	0.288	0.773
Duration of surgery (h, IQR)	1.2(1.0-2.0)	1.5(1.0-2.0)	-0.288	0.773
Blend sign \bar{n} %	50 \bar{n} 39.1%	41 \bar{n} 36.0%	0.247	0.619
Non-blend sign \bar{n} %	78 (60.9)	73 (64.0)	0.247	0.619
GCS=Glasgow Coma Scale; NIHSS=National Institute of Health Stroke				

Figures

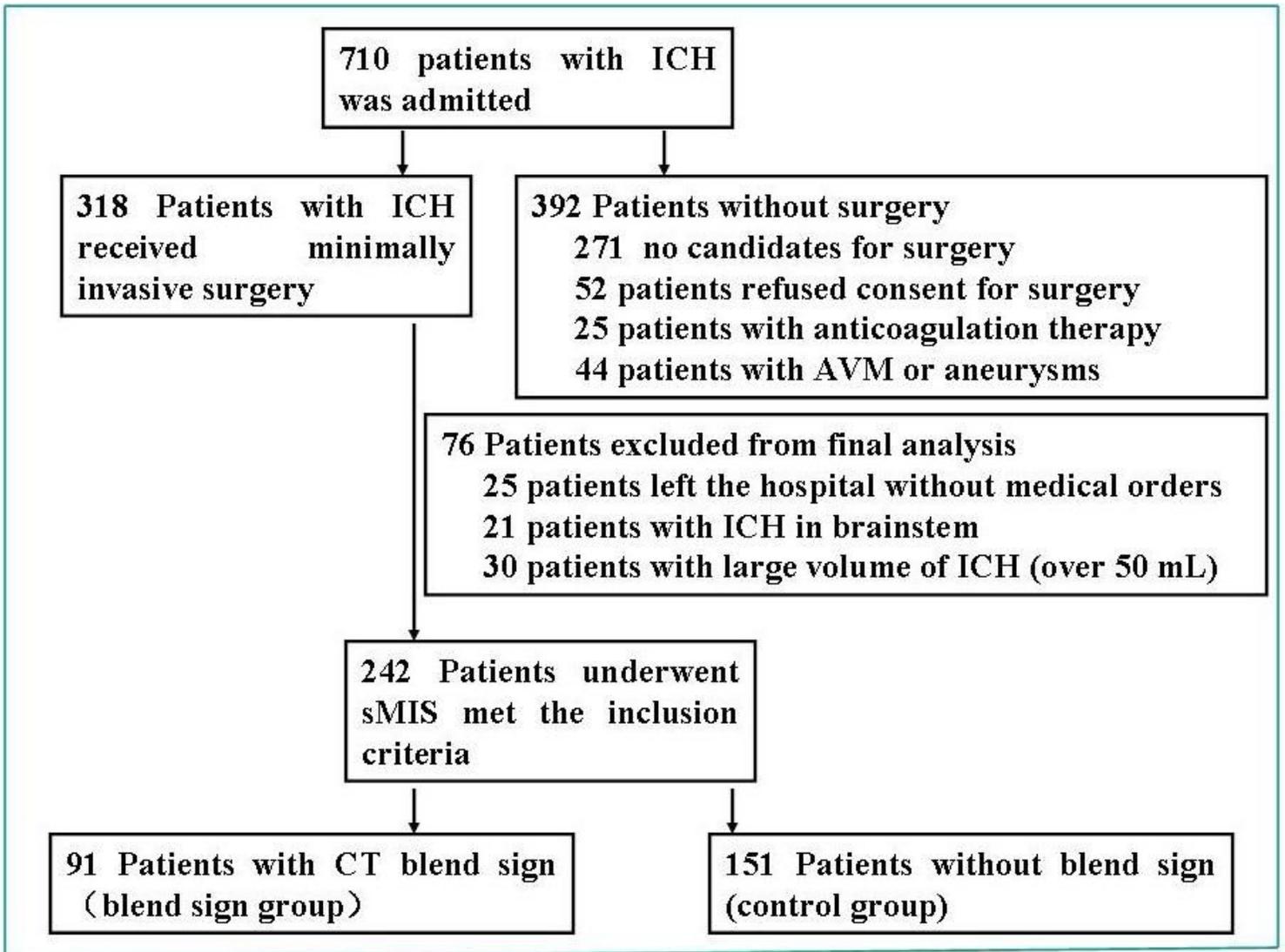


Figure 1

Blend signs on initial CT of patients with ICH The ICH was located in the right (A) or the left (B) basal ganglia. The blend signs were composed of a hyperdensity and a relative hypodensity (pointed by the arrow). The boundary of the two parts was easily identified by naked eyes.

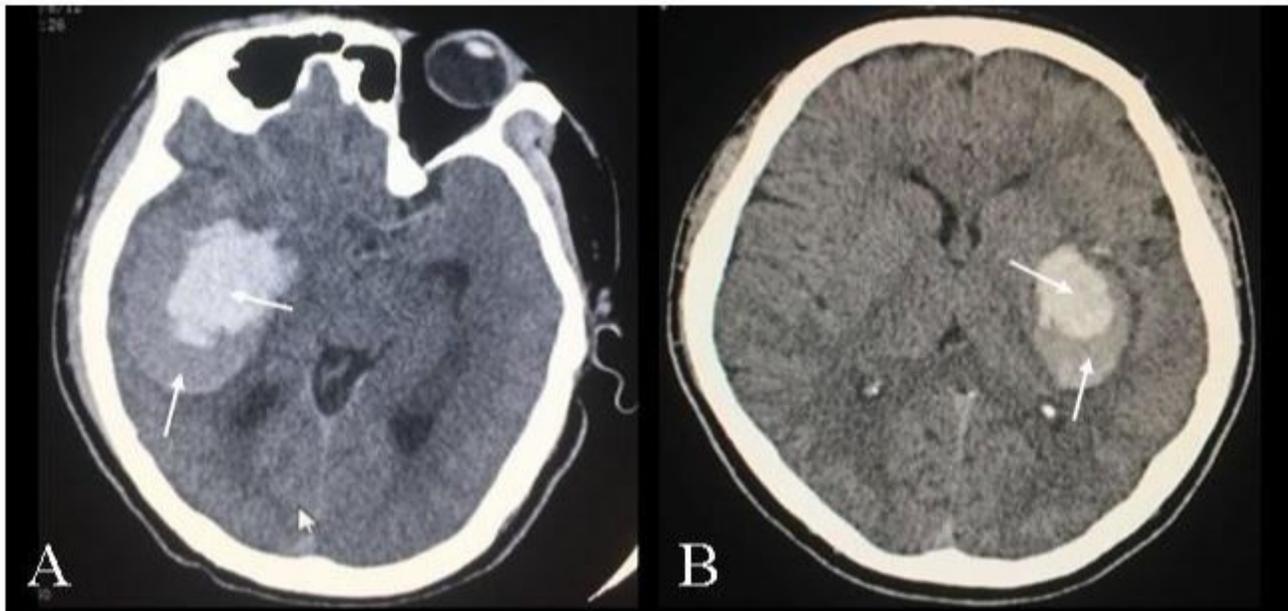


Figure 2

Procedures for the stereotactic minimally invasive surgery A Positioning headframe was fixed on the head firstly and then the patient was transferred for CT scan to figure out the coordinates (a-c). Subsequently the arc frame and guider were fixed to the positioning headframe and a transcranial puncture needle was inserted (d-f). Finally, the liquid part of the ICH was aspirated out (g-h)

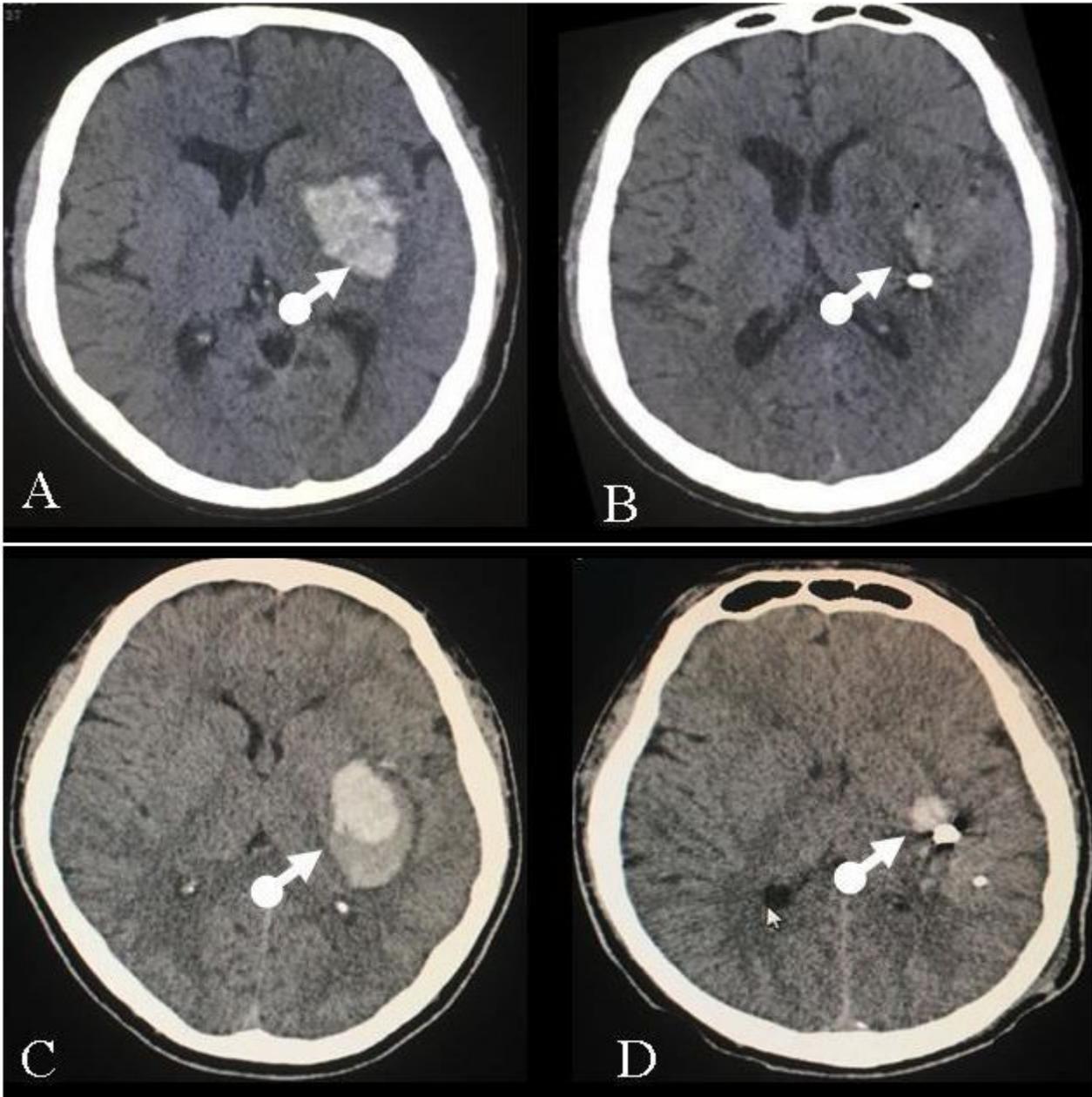


Figure 3

Changes in the haematoma volume after sMIS The haematoma volume decreased significantly after the sMIS in both the patients with non-blend signs (A-B) and the patients with blend signs(C-D).