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Original Article

Analysis of influencing factors of hemorrhagic transformation in patients with large vessel occlusion stroke after mechanical thrombectomy

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Abstract: Objective: To investigate the influencing factors of hemorrhagic transformation (HT) after mechanical thrombectomy (MT) in patients with large vessel occlusion (LVO) stroke. Methods: From September 2018 to December 2022, 270 eligible patients with LVO who underwent MT in the First Affiliated Hospital of Nanjing medical University were selected for this retrospective study, and the patients were divided into an occurrence group and a non-occurrence group based on the immediate and 24 h postoperative head CT results. The influencing factors of postoperative HT after MT were identified using univariate and logistic regression analyses. A Nomogram was constructed using logistic variables of significance. Then, area under the ROC curve (AUC) was used to verify the predictive efficacy of the Nomogram, and decision curve analysis (DCA) was used to test the clinical validity of the Nomogram. Results: HT occurred in 60 patients (23.70%) after MT. Logistic regression analysis showed that, male (OR=2.099, 95% CI: 1.051-4.193), age ≥71.5 years (OR=3.780, 95% CI: 1.836-7.782), preoperative NIHSS score ≥16.5 (OR=2.328, 95% CI: 1.112-4.873), operation time ≥58.5 min (OR=2.930, 95% CI: 1.294-6.634), and admission blood glucose ≥7.65 mmol/L (OR=4.915, 95% CI: 2.373-10.178) were risk factors for the occurrence of HT in patients with LVO stroke after MT. Admission serum magnesium ≥0.845 mmol/L (OR=0.225, 95% CI: 0.127-0.513) was a protective factor for the occurrence of HT in the patients after MT. The ROC curve showed that the AUC of the nomogram in the training set and test set were 0.849 (95% CI: 0.787-0.910) and 0.754 (95% CI: 0.634-0.874), respectively. DCA suggested that the nomogram revealed good clinical validity in the training and test sets. Conclusion: Sex, age, preoperative NIHSS score, operation time, blood glucose and serum magnesium levels at admission are influencing factors for the occurrence of HT in patients with LVO stroke after MT. The nomogram in this study has a good predictive efficiency, which can improve the diagnostic efficiency of HT after MT in patients with LVO stroke. Therefore, male patients with age ≥71.5 years, preoperative NIHSS score ≥16.5, operation time ≥58.5 min, admission blood glucose ≥7.65 mmol/L, and admission serum magnesium ≤0.845 mmol/L should raise awareness about the risk of HT after MT.

Keywords: Hemorrhagic transformation, stroke, large vascular occlusion, mechanical thrombectomy, influencing factors, nomogram

Introduction

Globally, stroke is the second leading cause of death and the main cause of disability, with ischemic stroke accounting for about 70% of all strokes [1]. Large vessel occlusion (LVO) stroke accounts for about 30% of ischemic strokes and leads to 60% of post-stroke life dependency and death, severely affecting human health and quality of life, and placing a huge burden on patients' families [2, 3]. Mechanical thrombectomy (MT) is an effective therapeutic method for patients with LVO stroke, which not only prolongs the treatment time window, but also significantly improves the vascular patency rate. It is a preferred treatment method for patients with LVO stroke who are contraindicated or ineffective to intravenous thrombolysis [4]. However, MT is more likely to cause a variety of complications than drug therapy alone, among which hemorrhagic transformation (HT) is the most common and serious complication

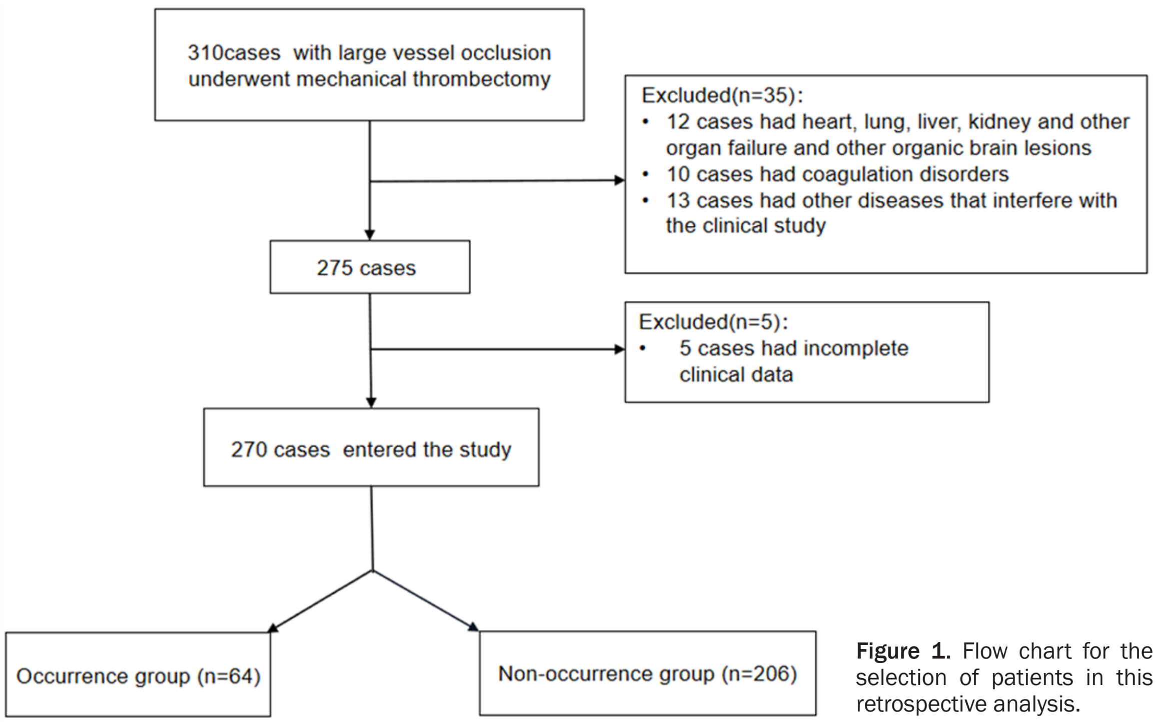

Figure 1. Flow chart for the selection of patients in this retrospective analysis.

after MT [5, 6]. Several studies have shown that the incidence of HT after MT was between 10% and 40%. HT can lead to poor prognosis, and even increase the risk of death in patients [7, 8]. Nomogram is a graphical statistical tool that can calculate and evaluate the probability of a patient's clinical outcome using continuous scores, and has been used to predict the occurrence of stroke in recent years [26]. At present, there are few studies on the influencing factors of HT in patients with LVO stroke after MT [9, 10], and there are almost no studies on the influencing factors of HT in patients with LVO stroke after MT combined with nomogram. Therefore, studying the factors affecting HT after MT is of great significance, because it can help to improve the clinical prognosis and quality of life of patients after the operation. This study intended to probe into the influencing factors of HT after MT in patients with LVO stroke, provide a theoretical basis for preoperative assessment, manage surgical risks, and reduce the incidence of HT after MT.

Subjects and methods

Subjects

From September 2018 to December 2022, 260 eligible patients with LVO who underwent MT in the First Affiliated Hospital of Nanjing Medical University were selected for retrospective study (**Figure 1**). Inclusion criteria: (1) patients with age ≥18 years; (2) patients who were diagnosed with LVO stroke by preoperative head CT examinations; (3) patients' family members agreed to undergo the procedures and signed an informed consent; (4) patients who completed the postoperative cranial CT or MRI review. Exclusion criteria: (1) patients with heart, lung, liver, kidney, or other organ failure, and other organic brain lesions; (2) patients with coagulation disorders; (3) patients with other diseases that interfere with the clinical study; (4) patients with incomplete clinical data. This study followed the Declaration of Helsinki and was approved by the Ethics Committee of The First Affiliated Hospital of Nanjing Medical University.

Methods

Relevant data of patients involved in the study were collected and sorted out, including: (1) demographic characteristics and personal habits: sex, age, smoking history, and drinking history; (2) past medical history: previous history of stroke, hypertension, atrial fibrillation, and diabetes mellitus; (3) clinical characteristics and surgery related indicators: preoperative

Table 1. General information and hemorrhagic transformation of patients with large vessel occlusion stroke

Indicators	Total number (n=270)	Occurrence group (n=64)	Non-occurrence group (n=206)
Age (years)	64.42±11.24	68.06±11.48	63.29±10.95
Sex [n (%)]			
Female	126 (46.67)	21 (32.81)	105 (50.97)
Male	144 (53.33)	43 (67.19)	101 (49.03)
Smoking [n (%)]			
No	173 (64.07)	40 (62.50)	133 (64.56)
Yes	97 (35.93)	24 (37.50)	73 (35.44)
Drinking [n (%)]			
No	125 (46.30)	25 (39.06)	100 (48.54)
Yes	145 (53.70)	39 (60.94)	106 (51.46)

National Institutes of Health Stroke Scale (NIHSS) score, operation time (time from puncture to vessel opening), and number of thrombectomy; (4) laboratory examination indexes: blood glucose level, neutrophil/lymphocyte ratio (NLR), platelet/lymphocyte ratio (PLR), and serum magnesium level at admission.

Outcome assessment indicators

All patients underwent CT scan immediately after surgery and again 24 hours after surgery. The primary outcome was whether HT occurred within 24 hours after the MT [17].

HT was defined as the occurrence of intracranial hemorrhage on the initial or second CT/MRI. HT is evaluated on the basis of imaging features and is usually divided into two main subtypes, hemorrhagic infarction (HI) caused by petechial hemorrhage and parenchymal hematoma (PH) [11]. To be specific, (1) HI-1: small speckle-like hemorrhage within the infarct; (2) HI-2: confluent plaque hemorrhage within the infarct; substantial hematoma; (3) PH-1: within the scope of infarcts <30% of the hematoma, mild placeholder effect; (4) PH-2: infarcts within the scope of >30% of hematoma, obvious placeholder effect. The patients were grouped according to the results of CT reexamination after operation. Namely, patients with intracranial HT on CT were included in an occurrence group, and those without in a non-occurrence group.

Statistical analysis

SPSS 26.0 was employed for statistical analysis. Data that passed the normality test were presented as Mean ± SD, and t-test was used for comparison between groups; data that failed the normality test were presented as M (P_{25}, P_{75}), and the Mann-Whitney U test was used for comparison between groups. Enumeration data were presented as frequency (%), and compared between groups by the χ^2 test. Logistic regression incorporated and analyzed the statistically significant factors from univariate analysis to determine the factors affecting HT after MT in patients with LVO stroke. A nomogram was constructed to predict the occurrence of HT after MT in LVO patients. The area under the ROC curve (AUC) and Decision curve analysis (DCA) were used to evaluate the predictive efficiency of the nomogram. P<0.05 was considered statistically significant.

Results

General data and HT

A total of 270 eligible patients with LVO stroke were included in this study, including 144 (53.33%) males and 126 (46.67%) females, with an average age of 64.42±11.24 years. There were 97 cases (35.93%) with a history of smoking and 145 cases (53.70%) with a history of alcohol consumption. HT developed in 64 cases (23.70%) after MT, and 206 cases (76.30%) did not develop HT. There were 34 cases (53.13%) of HI, and 30 cases (46.87%) of PH. Among the patients with HT, there were 43 males (67.19%) and 21 females (32.81%), 24 cases (37.50%) with smoking history and 40 cases (62.50%) without; 39 cases (60.94%) with a history of alcohol consumption and 25 cases (39.06%) without (**Table 1**).

Past medical history and HT

Among the 270 patients with LVO stroke, there were 44 cases (16.30%) with a history of stroke, 146 cases (70.87%) with hypertension, 103 cases (38.15%) with atrial fibrillation, and 103 cases (38.15%) with diabetes. Among the 64 patients with HT, there were 13 cases (20.31%) with a history of previous stroke and 51 cases (79.69%) without, 30 cases (46.87%) with a history of hypertension and 34 cases (53.13%)

Table 2. Past medical history and hemorrhagic transformation of patients with large vessel occlusion stroke

Indicators	Total number (n=270)	Occurrence group (n=64)	Non-occurrence group (n=206)
Past stroke history [n (%)]			
No	226 (83.70)	51 (79.69)	175 (84.95)
Yes	44 (16.30)	13 (20.31)	31 (15.05)
Hypertension [n (%)]			
No	124 (60.19)	34 (53.13)	90 (43.69)
Yes	146 (70.87)	30 (46.87)	116 (56.31)
Diabetes [n (%)]			
No	213 (78.89)	48 (75.00)	165 (80.10)
Yes	57 (21.11)	16 (25.00)	41 (19.90)
Atrial fibrillation [n (%)]			
No	167 (61.85)	39 (60.94)	128 (62.14)
Yes	103 (38.15)	25 (39.06)	78 (37.86)

without, 16 cases (25.00%) with a history of diabetes and 48 cases (75.00%) without, 25 cases (39.06%) with a history of atrial fibrillation and 39 cases (60.94%) without (**Table 2**).

Surgery-related indicators and HT

Among the 270 patients with LVO stroke, the mean preoperative NIHSS score was 17.81±5.63, the average operation time was 69 (52, 86.25) minutes, and the mean number of thrombectomy was 3 (2, 4). In patients with HT, the preoperative NIHSS score was 20.02±5.29, the operation time was 78 (62.25, 92.75) minutes, and the number of thrombectomy was 3 (3, 3). In patients without HT, the preoperative NIHSS score of patients without HT was 17.13±5.56, the operation time was 65.5 (50, 83.25) minutes, and the number of thrombectomy was 3 (2, 4) (**Table 3**).

Laboratory indexes and HT

Among the 270 patients with LVO stroke, the average blood glucose level at admission was 6.69±1.26 mmol/L, the NLR was 3.36 (2.55, 4.50), the PLR was 115.56 (92.79, 166.27), and the serum magnesium level was 0.89±0.16 mmol/L. In patients who developed HT, the blood sugar level was 7.30±1.54 mmol/L, NLR was 3.70 (2.87, 5.45), PLR was 114.83 (90.26, 182.37), and serum magnesium level was 0.80±0.18 mmol/L. In patients without HT, the blood glucose level at admission was 6.50±1.09 mmol/L, NLR was 3.35 (2.44, 4.50), PLR was 115.92 (93, 125.26), and serum magnesium level was 0.92±0.14 mmol/L (**Table 4**).

Univariate analysis of factors associated with HT in patients with LVO stroke after MT

The patient data were analyzed and compared between the occurrence and non-occurrence groups. It was found that there were significant differences between the two groups in terms of sex (P=0.011), age (P=0.003), preoperative NIHSS score (P<0.001), operation time (P<0.001), blood glucose (P<0.001), and serum magnesium (P<0.001) levels at admission (**Table 5**).

Logistic regression analysis of factors associated with HT in patients with LVO stroke after MT

Whether HT occurred after MT in the patients (no occurrence =0, occurrence =1) was taken as the dependent variable, and independent variables were the statistically significant variables from univariate analysis (sex, age, NIHSS score, operation time, blood glucose, and serum magnesium). Continuous variables were divided according to the optimal cutoff value in ROC curve for logistic regression analysis, and binary classification variables assignment was shown in **Table 6**. Multivariate Logistic regression analysis displayed that sex (P=0.036), age (P<0.001), preoperative NIHSS score (P=0.025), operation time (P=0.010), blood glucose (P<0.001), and serum magnesium level at admission (P<0.001) were all influencing factors for HT in patients with LVO stroke after MT. Among them, male (OR=2.099, 95% CI: 1.051-4.193), age ≥71.5 years (OR=3.780, 95% CI: 1.836-7.782), preoperative NIHSS score ≥16.5 points (OR=2.328, 95% CI: 1.112-4.873), operation time ≥58.5 min (OR=2.930, 95% CI: 1.294-6.634) and blood glucose ≥7.65 mmol/L (OR=4.915, 95% CI: 2.373-10.178) were risk factors for HT. Serum magnesium ≥0.845 mmol/L (OR=0.225, 95% CI: 0.127-0.513) was a protective factor against HT after MT in the patients (**Table 7**).

Table 3. Operation-related indexes and hemorrhagic transformation of patients with large vessel occlusion stroke

Indicators	Total number (n=270)	Occurrence group (n=64)	Non-occurrence group (n=206)
NIHSS score (points)	17.81±5.63	20.02±5.29	17.13±5.56
Operation time (min)	69 (52, 86.25)	78 (62.25, 92.75)	65.5 (50, 83.25)
Number of thrombectomy (times)	3 (2, 4)	3 (3, 3)	3 (2, 4)

Note: NIHSS: National Institutes of Health Stroke Scale.

Table 4. Laboratory indexes and hemorrhagic transformation of patients with large vessel occlusion stroke

Indicators	Total number (n=270)	Occurrence group (n=64)	Non-occurrence group (n=206)
Blood glucose (mmol/L)	6.69±1.26	7.30±1.54	6.50±1.09
Neutrophil count (10^9 L)	5.98±1.53	6.08±1.65	5.95±1.50
Lymphocyte count (10^9 L)	1.82±0.63	1.83±0.68	1.82±0.62
Neutrophil/lymphocyte ratio	3.36 (2.55, 4.50)	3.70 (2.87, 5.45)	3.35 (2.44, 4.50)
Platelet Count (10^9 L)	217.00±34.39	215.18±37.38	217.56±33.49
Platelet/lymphocyte ratio	115.56 (92.79, 166.27)	114.83 (90.26, 182.37)	115.92 (93, 125.26)
Serum magnesium (mmol/L)	0.89±0.16	0.80±0.18	0.92±0.14

Nomogram of HT in patients with LVO stroke after MT

According to the results of Logistic regression analysis, a total of 6 variables including sex, age, preoperative NIHSS score, operation time, blood glucose, and serum magnesium levels at admission were used as predictors to construct the nomogram (**Figure 2**). The nomogram consisted of the initial values of the predictors, the initial score range, the total score, and the probability of occurrence of HT. The red dots corresponded to the corresponding initial scores for each variable of the patient. The total score was obtained by adding all these initial scores, and the final arrow indicated the percentage corresponding to the total score, representing the individual probability of HT after MT in LVO stroke patients. We took patient number 236 as an example in the figure, the total score of each variable score was 1.97, and the corresponding probability of HT after MT was 51.5%.

The ROC curve showed that the AUC of the nomogram in the training set and the test set were 0.849 (95% CI: 0.787-0.910) and 0.754 (95% CI: 0.634-0.874), respectively, indicating that it had good prediction efficiency (**Figures 3** and **4**). DCA showed that when the threshold probability was between 4.0% and 90.0% in the training set and between 6.0% and 85.0% in the test set, the nomogram had a greater net benefit in predicting HT than the "all occurrence" or "none occurrence" strategy, indicating that the nomogram had good clinical validity in the training and test sets (**Figure 5**).

Discussion

MT can improve the recanalization rate and significantly improve the prognosis of patients with LVO stroke [12]. However, HT is a common complications after MT, and it not only has a high disability rate and mortality, but it also reduces the therapeutic effect of patients after MT [13, 14]. Therefore, it is of great practical significance to analyze and identify the factors that influence the occurrence of HT after MT. In this study, the patients with LVO stroke who underwent MT in our hospital were retrospectively analyzed, and the factors affecting the HT after MT were preliminarily analyzed by univariate and logistic regression analyses. Additionally, a nomogram was constructed to predict the probability of HT after MT in patients with LVO stroke, and the AUC of the ROC curve and DCA were used to verify the predictive effi-

Table 5. Univariate analysis

Factors	Occurrence group (n=64)	Non-occurrence group (n=206)	t/Z/χ^2	P
Age (years)	68.06±11.48	63.29±10.95	-3.013	0.003
Sex [n (%)]			6.469	0.011
Female	21 (32.81)	105 (50.97)		
Male	43 (67.19)	101 (49.03)		
Smoking [n (%)]			0.090	0.764
No	40 (62.50)	133 (64.56)		
Yes	24 (37.5)	73 (35.44)		
Drinking [n (%)]			1.765	0.184
No	25 (39.06)	100 (48.54)		
Yes	39 (60.94)	106 (51.46)		
Past stroke history [n (%)]			0.992	0.319
No	51 (79.69)	175 (84.95)		
Yes	13 (20.31)	31 (15.05)		
Hypertension [n (%)]			1.751	0.186
No	34 (53.13)	90 (43.69)		
Yes	30 (46.87)	116 (56.31)		
Diabetes [n (%)]			0.762	0.383
No	48 (75.00)	165 (80.10)		
Yes	16 (25.00)	41 (19.90)		
Atrial fibrillation [n (%)]			0.030	0.863
No	39 (60.94)	128 (62.14)		
Yes	25 (39.06)	78 (37.86)		
NIHSS score (points)	20.02±5.29	17.13±5.56	-3.664	<0.001
Operation time (min)	78 (62.25, 92.75)	65.5 (50, 83.25)	-3.576	<0.001
Number of thrombectomy (times)	3 (3, 3)	3 (2, 4)	-0.923	0.356
Neutrophil/lymphocyte ratio	3.70 (2.87, 5.45)	3.35 (2.44, 4.50)	-0.190	0.850
Platelet/lymphocyte ratio	114.83 (90.26, 182.37)	115.92 (93, 125.26)	-0.384	0.701
Blood glucose (mmol/L)	7.30±1.54	6.50±1.09	-4.599	<0.001
Serum magnesium (mmol/L)	0.80±0.18	0.92±0.14	5.426	<0.001

Note: NIHSS: National Institutes of Health Stroke Scale.

Table 6. Assignment and description

Factors	Assignment
Sex	Female =0, Male =1
Age	≥71.5 years =1, <71.5 years =0
NIHSS score	≥16.5 points =1, <16.5 points =0
Operation time	≥58.5 min =1, <58.5 min =0
Blood glucose	≥7.65 mmol/L =1, <7.65 mmol/L =0
Serum magnesium	≥0.845 mmol/L =1, <0.845 mmol/L =0

Note: NIHSS: National Institutes of Health Stroke Scale.

cacy of the nomogram. Our objective is to provide preliminary basis for predicting and reducing the risk of HT after MT in patients with LVO stroke.

In this study, the incidence of HT in patients with LVO stroke who underwent MT was 23.70%, which was lower than that reported by Tian et al. [15] and Omran et al. [16]. Sex, age, preoperative NIHSS score, operation time, blood glucose level, and serum magnesium level at admission were all influencing factors for the occurrence of HT after MT in patients with LVO stroke. (1) Sex: The studies of Lee et al. [17] and Lancu et al. [18] found that males had a higher risk of HT after MT than females, which is relatively similar to our results. (2) Age: This study found that age ≥71.5 years old was a risk factor for the occur-

Table 7. Logistic regression analysis

Factors	β	S.E.	Wald	P	OR	95% CI
Sex	0.742	0.353	4.414	0.036	2.099	1.051~4.193
Age	1.330	0.368	13.024	<0.001	3.780	1.836~7.782
NIHSS score	0.845	0.377	5.030	0.025	2.328	1.112~4.873
Operation time	1.075	0.417	6.644	0.010	2.930	1.294~6.634
Blood glucose	1.592	0.371	18.378	<0.001	4.915	2.373~10.178
Serum magnesium	-1.366	0.357	14.651	<0.001	0.225	0.127~0.513

Note: NIHSS: National Institutes of Health Stroke Scale.

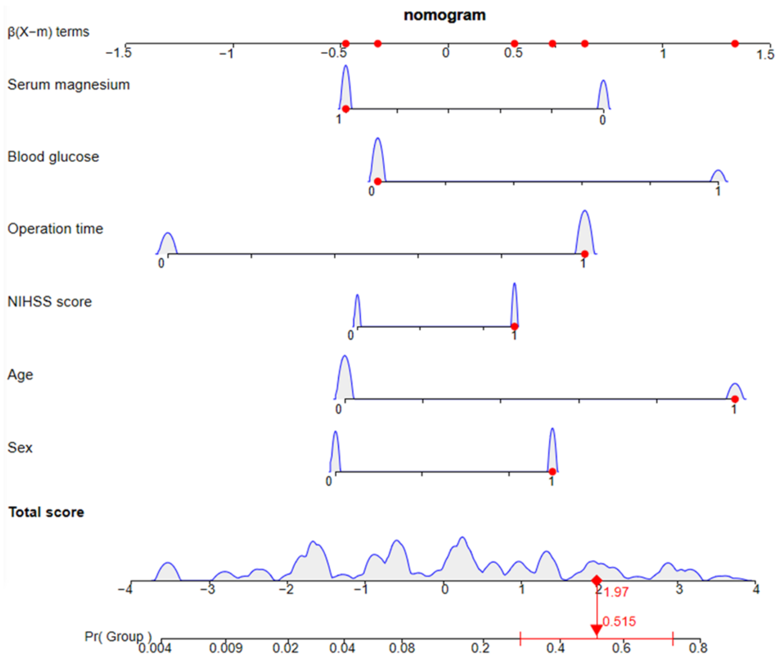

Figure 2. Nomogram for hemorrhagic transformation after mechanical thrombectomy in large vessel occlusion stroke patients. Note: NIHSS: National Institutes of Health Stroke Scale.

rence of HT. Pande et al. [19] and Andrade et al.'s [20] studies also reported that advanced age was a risk factor for HT, which is similar to the results of our study. The reason may be that the physical function and vascular condition of elderly patients is worse than that of young patients, so the operation is more difficult, and the surgical effect is not as good as that of young patients. (3) NIHSS score: Preoperative NIHSS score ≥16.5 points was a risk factor for HT after MT. Studies by Tian et al. [15] and Johannes et al. [21] showed that the risk factor for HT was related to higher admission NIHSS score, which is similar to our research results. A high NIHSS score indicates that there may be a larger infarction focus in patients with LVO stroke, suggesting more serious blood-brain barrier damage and higher probability of HT after operation. (4) Operation time: This study found that operation time ≥58.5 min was a risk factor for HT, and operation time was defined as the time from puncture to successful recanalization of the vessel. Huang et al. [22] found that operation time was related to the occurrence of HT in patients after MT, and the longer the operation time, the greater the risk of HT. Lee, et al. [17] found that longer operating time was independently related to high incidence of HT. These results are similar to ours. Increased incidence of postoperative bleeding may be attributed to the prolonged surgical time and the expansion of the cerebral infarction area. These factors can lead to heightened permeability of blood vessel walls and an elevated risk of reperfusion injury. At the same time, when patients undergo longer and more complex procedures, it increases the operation time. This prolonged surgery duration can lead to more severe vascular endothelial injury. Hence, it is essential to enhance the transitional measures for patients to mitigate the risk of postoperative bleeding. (5) Blood glucose: This study found that blood glucose ≥7.65 mmol/L was a risk factors of HT. The study by Wen et al. [23] showed that hyperglycemia was a strong predictor of HT. Tian et al. [15] and Lancu et al. [18] found that higher blood glucose levels were associated with an increased risk of HT. Andrade et al. [20] and Johannes et al. [21] reported that the risk factors of HT were related to higher blood glucose levels at admission. These are similar to the findings obtained in our study. The reason for this may be that the increase of blood glucose can elevate the per-

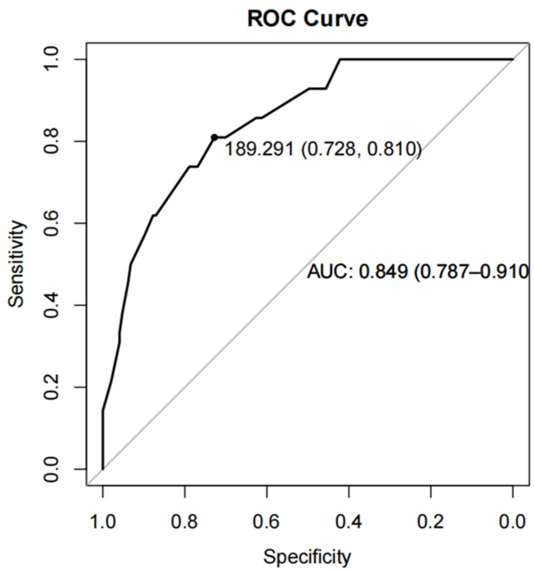

Figure 3. ROC curve of the nomogram in the training set.

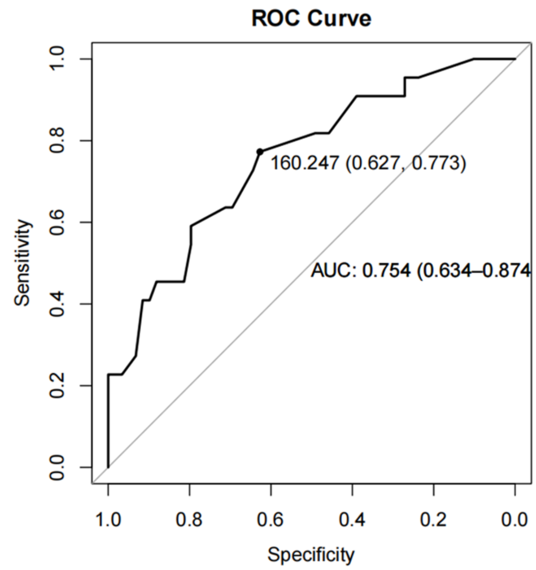

Figure 4. ROC curve of the nomogram in the test set.

meability of the blood-brain barrier, induce the thrombotic inflammatory cascade, promote the apoptosis of microvascular endothelial cells, increase anaerobic glycolysis, cause acidosis, and thus increase the risk of HT after MT. (6) Serum magnesium: This study found that serum magnesium ≥0.845 mmol/L at admission was a protective factor for HT. Qiu et al. [24] showed that low serum magnesium level at admission was associated with an increased risk of HT after MT. Cheng et al. [25] demonstrated that a decrease in serum magnesium level was associated with an increased risk of HT. These findings are similar to our results. This may be related to the role of magnesium in neuroprotection and hemostasis. Low serum magnesium levels can cause inflammatory cascade reaction, destroy the integrity of the blood-brain barrier, and lead to vascular endothelial damage, thereby increasing the bleeding tendency, which is associated with postoperative HT.

The overall prediction performance of our nomogram were (AUC: 0.849; 95% CI: 0.787-0.910) and (AUC: 0.754; 95% CI: 0.634-0.874) in the training set and the test set. It is indicated that this nomogram can help doctors to identify patients with high risk of HT after MT. DCA was a special tool for evaluating the clinical utility of nomograms, and the results showed that our nomogram was clinically effective for predicting HT after MT. Nomogram can transform complex regression equations into visual figures, making the prediction results easier to read and patients' condition more convenient to evaluate. It can be used to predict the risk of HT in clinical practice and assist clinicians to make decisions.

There are some limitations in this study: (1) This is a retrospective study, and the homogeneity of various clinical data could not be guaranteed, so it was impossible to avoid insufficient statistical power or bias caused by some confounding factors. (2) This is a single-center and small-sample study, and only included patients from our hospital, so the results had certain limitations. Future studies can collect multi-center and large-sample data to improve the accuracy of the model. (3) The nomogram was not validated in external cohorts. Therefore, multi-center prospective studies can be established to verify the applicability of our nomogram in the future. (4) There are limited influencing factors included in this study, and future research can collect more variables to improve the accuracy of the nomogram prediction. Therefore, accurate and comprehensive nomogram may provide individualized and precise prediction of HT risk after MT in patients with LVO stroke, which may be the focus of future research.

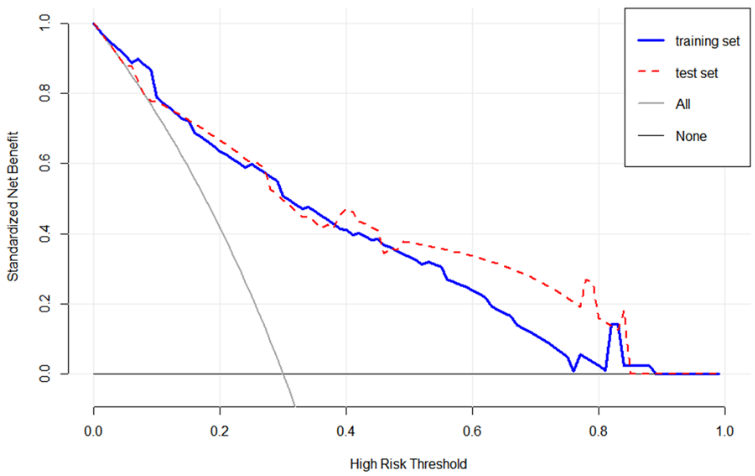

Figure 5. Decision curves of the nomogram in the training and test sets. Note: The thick gray line indicates that none of the patients developed HT, the thin oblique gray line indicates that all patients developed HT after MT, and the blue and red lines represent the net benefits of the nomogram in the training set and validation set, respectively. HT: hemorrhagic transformation, MT: mechanical thrombectomy.

In conclusion, sex, age, preoperative NIHSS score, operation time, admission blood glucose, and serum magnesium level at admission are influencing factors for the occurrence of HT after MT in patients with LVO stroke. The nomogram in this study has good predictive efficiency and clinical validity, which can improve the diagnostic efficiency of HT after MT in patients with LVO stroke. Therefore, male patients with age ≥71.5 years, preoperative NIHSS score ≥16.5, operation time ≥58.5 min, admission blood glucose ≥7.65 mmol/L, and admission serum magnesium ≤0.845 mmol/L should raise awareness about the risk of HT after MT.

Disclosure of conflict of interest

None.

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