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Original Article

Using Glasgow Coma Scale to Identify Acute Large-Vessel Occlusion Stroke

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SUMMARY

Background: Patients with acute cerebral large-vessel occlusion (LVO) are candidates for thrombectomy. Early detection of LVO by emergent triage according to clinical symptoms is difficult. We aimed to investigate the usefulness of evaluation using the Glasgow Coma Scale (GCS) in acute stroke patients to predict possible LVO.
Methods: We retrospectively evaluated our stroke registry data from Jan. to Dec. 2015. Patients diagnosed with acute stroke in our emergency room (ER) within 6 hours of stroke onset were included. All LVO patients were documented on magnetic resonance imaging or computed tomography angiography after admission. We analyzed the relationship between GCS and LVO.
Results: Altogether, 319 acute stroke patients presenting to the ER within 6 hours of stroke onset were included and analyzed. Eighty-two (25.7%) patients had LVO and were possible candidates for thrombectomy. Patients in the LVO group were significantly older (73 ± 12 years, $p < 0.05$) and showed a greater incidence of atrial fibrillation (45% vs. 13%, $p < 0.001$) and dense artery sign on non-contrast computed tomography (61% vs. 1%, $p < 0.001$). The non-LVO group had a greater proportion of male patients (64% vs. 48%). GCS showed fair sensitivity (94%) and specificity (90%) in predicting LVO stroke. The positive predictive value was 77% and the negative predictive value was 98%. The odds ratio for LVO with GCS score < 15 was 60.39 (95% confidence interval: 13.32–273.83).
Conclusion: GCS evaluation at triage can help in early detection of patients with LVO stroke and may hasten the protocol of intra-arterial thrombectomy.

1. Introduction

The burden of stroke remains the second cause of death and the main cause of disability worldwide.[1] In the classification of ischemic stroke, large-vessel occlusion (LVO) is a catastrophic event and a major contributor to mortality and morbidity.[2] LVO-related stroke including the anterior and the posterior circulation accounts for 11–24% of the total cases of stroke and needs emergent treatment.[3,4] Over the past years, several randomized-controlled trials have established that intra-arterial thrombectomy (IAT) is a standard treatment that can significantly improve the outcomes in LVO patients.[5] Reportedly, the prognosis of IAT is inversely correlated with door-to-puncture time and the recommended duration for the start of IAT is within 6 hours after stroke onset.[6,7] With the increasing use of IAT in patients with acute infarction, early detection of LVO patients in the emergency room (ER) is important. National Institutes of Health Stroke Scale (NIHSS) is the most common predictive scale and is strongly associated with the presence of LVO.[8] However, a complete NIHSS examination is complicated and cannot be completed at emergency triage or during the pre-hospital ambulance care. Therefore, many scales such as the FAST PLUS Test,[9] Gaze-Face-Arm-Speech-Time score,[10] Speech Arm Vision Eyes scale,[11] Rapid Arterial Occlusion Evaluation,[12] and Vision Aphasia Neglect scale have been established for quick prediction of LVO.[13] The Glasgow Coma Scale is a three-item scale that includes eye, verbal, and motor responses to evaluate patient consciousness. We aimed to investigate the usefulness of GCS evaluation in acute stroke patients to predict possible LVO.

2. Patients and methods

We retrospectively analyzed the prospective stroke registry data from Jan. to Dec. 2015 in an academic tertiary hospital. Patients diagnosed with acute ischemic stroke in our ER within 6 hours after the onset of stroke were enrolled. All patients were assessed using GCS at the ER triage by a well-trained nurse. All patients underwent computed tomography (CT) angiography or magnetic resonance imaging to confirm LVO stroke after admission. GCS is composed of three components: eye, verbal, and motor responses. LVO was defined as acute occlusion of the internal carotid artery (ICA), first division (sphenoidal segment) of the middle cerebral artery (MCA), second division (insular segment) of the MCA (M2), vertebral artery, or basilar artery (BA). Using our registry, data regarding initial symptoms at triage, initial blood pressure, electrocardiogram, and hyperdense MCA sign on non-contrast brain CT scan were collected and analyzed.

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2.1. Statistical methods

Continuous variables were presented as mean ± standard deviation and categorical variables were presented as number (percentage). We used 2 × 2 tables and the chi-squared test or the Fisher's exact test to evaluate the association between the variables. Multivariable logistic regression was performed to determine the independent predictive factors for LVO. Statistical analyses were performed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA). The study complied with the 1975 Helsinki Declaration on ethics in medical research and was reviewed by the Institution Review Board of Mackay Memorial Hospital.

3. Results

We enrolled 319 patients who presented to the ER with acute stroke symptoms within 6 hours after stroke onset. Among these, 25.7% (n = 82) of the patients had LVO and were possible candidates for thrombectomy. No significant differences were observed in systolic and diastolic blood pressures between the LVO group and the non-LVO group (Table 1). The LVO group had a higher incidence of change in consciousness compared to the initial presentation at the ER triage and no isolated incidence of dizziness or slurred speech. We also observed that patients in the LVO group were significantly older (73 ± 12 years, $p < 0.05$) and showed a greater incidence of atrial fibrillation (45% vs. 13%, $p < 0.001$) and not full GCS scale (93.9% vs. 9.3%, $p < 0.001$) than the non-LVO group. The non-LVO group had a higher proportion of male patients (64% vs. 48%, $p < 0.001$). In the imaging analysis, dense artery sign was a significant predictive factor for LVO (61% in the LVO group vs. 1.3% in the non-LVO group, $p < 0.001$). A strong correlation was observed between LVO stroke and GCS score less than the maximum value. The decrease response in each component of GCS has a significant difference between the LVO group and the non-LVO group, in which the decrease level of verbal component has highest incidence in LVO group.

In Figure 1, we constructed a receiver operating characteristic (ROC) curve of GCS for predicting whether patient have LVO. The area under curve (AUC) was 0.935 ($p < 0.001$, 95% CI 0.900–0.970). The optimum cut-off GCS was 14.5. Under the result, it is reasonable to use GCS < 15 for LVO detection. GCS < 15 exhibited fair sensitivity (94%) and specificity (90%) in predicting LVO stroke (Table 2). The positive predictive value was 77% and the negative predictive value was 98%.

In the logistic regression analysis (Table 3), the odds ratio for LVO patients with GCS score < 15 was 60.39 (95% confidence interval: 13.32–273.83) after adjusting for age.

4. Discussion

In our registry data, 25.7% of the acute stroke patients presenting to the ER within 6 hours after stroke onset had an LVO-type infarction. This result is similar to the results reported in previous

Table 1
Clinical characteries of total study patients.

	LVO (n = 82)	Non-LVO (n = 237)	p-value
Age (years)	73 ± 12	69 ± 13	< 0.001
Sex (male)	48%	64%	0.012
Systolic BP (mmHg)	158 ± 33	160 ± 32	0.67
Diastolic BP (mmHg)	81 ± 19	83 ± 18	0.47
NIHSS	18 ± 5.6	5 ± 4.3	< 0.001
Initial complain at triage			
Hemiparesis	74%	67%	
Change in consciousness	26%	1%	
Slurred speech or dizziness	0%	32%	
Afib at ER	45%	13%	< 0.001
Dense artery sign in brain CT	61%	1%	< 0.001
GCS < 15 (less than maximum score)	94%	9%	< 0.001
CGS-Eye < 4 (less than maximum score)	56.1%	2.9%	< 0.001
GCS-Motor < 6 (less than maximum score)	73.1%	5.4%	< 0.001
GCS-Verbal < 5 (less than maximum score)	82.9%	9.2%	< 0.001

Data are presented as mean ± standard deviation or percentages.
Afib: atrial fibrillation, BP: blood pressure, CT: computed tomography, ER: emergency room, GCS: Glasgow Coma Scale, LVO: large-vessel occlusion, NIHSS: National Institutes of Health Stroke Scale.

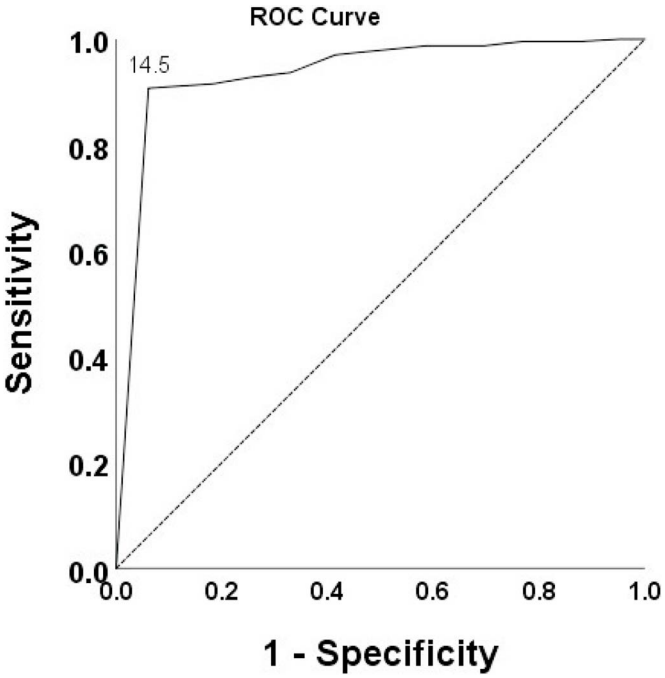

Figure 1. ROC curve of GCS to predict LVO.

Table 3
Results of multivariate logistics regression (adjusted age).

	OR	95% CI	p value
GCS < 15	60.39	13.32–273.83	< 0.001
NIHSS ≥ 8	4.14	1.00–17.16	0.05
Dense artery sign	32.95	5.99–181.25	< 0.001
Afib in ER	4.25	1.22–14.83	0.02

Table 2
Sensitivity and specificity of GCS to predict LVO.

	LVO	Non-LVO	
GCS < 15 (less than maximum score)	77	22	Positive predictive value = 77%
GCS = 15 (maximum score)	5	215	Negative predictive value = 98%
	Sensitivity = 94%	Specificity = 90%	

Data are presented as number of patients.
GCS: Glasgow Coma Scale, LVO: large-vessel occlusion.

studies. Thus, ER physicians should be aware that approximately a quarter of acute stroke patients require aggressive endovascular thrombectomy. Interestingly, according to the initial chief complaints noted at triage, some patients' chief complaints were dizziness or change in consciousness rather than hemiparesis. However, almost all patients with change in consciousness belonged to the LVO group and no patient with isolated incidence of dizziness had LVO. We noted gender and age differences between the groups. Patients from the LVO group were older than those in the non-LVO group and male predominance was observed in the non-LVO group. The difference in age between the groups may explain the greater incidence of atrial fibrillation in the LVO group, as the prevalence of atrial fibrillation increases with age.[14] The male predominance in the non-LVO group may be explained by the fact that men have a higher overall incidence of stroke.[15]

In routine practice, the GCS scores were checked in every patient at the ER triage. It is well known that infarction in the large main trunk territory of the MCA usually results in decreased consciousness and lower GCS scores. GCS scoring is also useful in detecting distal MCA branch infarctions, such as those in the M2 segment. In M2 segment infarctions, significant aphasia in the dominant hemisphere and eyelid apraxia in the non-dominant hemisphere may be observed. This results in decreased scores in the verbal and eye components of GCS.[16] In patients with BA occlusion (BAO), abnormal posture such as decerebrate or decorticate posture is commonly observed along with decreased score in the motor component of GCS.[17] Our study has documented the usefulness of GCS in detection of LVO. However, we found that some patients with GCS score of 15 (maximum GCS score) had LVO. It is often observed in the M2 segment of the non-dominant MCA.

It is well known that the dense artery sign is commonly observed on brain CT in LVO stroke.[18] In our study, only 61% of the patients exhibited this sign. Thus, it could not be considered a reliable marker of LVO. We believe that the hyperdense MCA sign cannot be observed in distal or proximal ICA occlusion due to patent MCA in such cases. Cardioembolic stroke is the primary etiology of acute LVO.[19] Our study showed that 45% of the patients had atrial fibrillation on electrocardiogram in the ER. The incidence of atrial fibrillation in the present study was lower than that reported in other studies, possibly due to the large proportion of patients having paroxysmal atrial fibrillation that cannot be detected on electrocardiogram in the ER.

Several research groups have developed pre-hospital stroke severity and LVO screening tools. To the best of our knowledge, we are the first team to elucidate the usefulness of GCS. However, our study has some limitations. It was a single-center study at a tertiary hospital where the examinations were conducted by well-trained nurses at ER triage. More data from local hospitals are needed to test the generalizability of our results regarding the utility of GCS in LVO stroke. In the present study, cerebral vessel imaging was performed after the emergency treatment. Since IAT was not an option in 2015, intravenous recombinant tissue plasminogen activator (rtPA) therapy was the standard treatment[20] with less than 20% success rate in LVO. In our study, 13% (44/319) of the patients underwent rtPA thrombolysis. The rate of LVO in the present study was probably underestimated and further studies are needed to elucidate the incidence of LVO.

In conclusion, GCS evaluation is a reliable method for the initial screening for LVO. Approximately a quarter of patients who reported to the ER within 6 hours after stroke onset had LVO and needed aggressive treatment. We believe that this commonly used scale can hasten the thrombectomy protocol.

Conflicts of interest

I have no conflicts of interest.

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