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Research Article

The Use of CHA_2DS_2-VASc Score to Predict Functional Outcomes of Mechanical Thrombectomy

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Abstract

Background: Mechanical thrombectomy is widely used for revascularization of acute ischemic strokes from large vessel occlusions. Functional outcomes following mechanical thrombectomy are typically assessed using the modified Rankin scale. CHA_2DS_2-VASc score is commonly used to estimate the stroke risk of patients with atrial fibrillation, but studies have verified its use in other various situations. Our study aimed to assess the utility of CHA_2DS_2-VASc score in predicting outcomes of patients undergoing mechanical thrombectomy.

Methods: We performed a single center retrospective study. Of patients with acute ischemic stroke who underwent mechanical thrombectomy for large vessel occlusion (n = 448). CHA_2DS_2-VASc score was calculated on each patient and the study population was grouped based on low-risk ≤ 2, intermediate risk 3-4 and high-risk ≥ 5. Association between CHA_2DS_2-VASc score and 90-day modified Rankin score as well as in-hospital, 30-day, and 1-year mortality was evaluated and compared between the three groups.

Results: A total of 312 patients met criteria for the study. Patients in the high-risk CHA_2DS_2-VASc score had a significantly higher modified Rankin score (4.48) when compared to low (2.57) and intermediate (3.82) risk groups. Higher CHA_2DS_2-VASc scores were also associated with a significantly higher in-hospital, 30-day, and one year mortality.

Conclusion: CHA_2DS_2-VASc score, a simple bed-side tool, can predict higher mortality and worse functional outcomes in acute ischemic stroke patients undergoing mechanical thrombectomy for large vessel occlusions.

Keywords: Mechanical thrombectomy, CHA2DS2-VASc Score, Ischemic stroke, Modified Rankin Score

Introduction

Mechanical thrombectomy has been widely accepted as the gold standard therapy for acute ischemic stroke (AIS) secondary to large vessel occlusion (LVO) [1,2]. Multiple large clinical trials have demonstrated that endovascular therapy is safe, effective, and significantly improves long-term functional outcomes following an AIS when compared to medical therapy [3-8]. Functional outcome, independence, and disability are commonly measured 90 days after mechanical thrombectomy using the modified Rankin score (mRS). Scoring systems to predict functional outcomes and mortality following an AIS have been well established in the literature [9-16]. Additionally, with the increasing use of mechanical thrombectomy, experts have also developed scores to predict mechanical thrombectomy outcomes. While initial scoring systems focus primarily on pre-thrombectomy radiologic findings, more recent ones have also included clinical parameters to predict post-procedural as well as functional outcomes. Examples of such scores include GADIS (Gender, Age, Diabetes mellitus history, Infarct volume, and current Smoker) and the THRIVE (Totaled Health Risks in Vascular Events) scores. These scores have demonstrated that chronic medical comorbidities can significantly influence short-term post-thrombectomy prognosis and functional outcome [17,18]. Many proceduralist utilize these scores as helpful adjuncts to neuroimaging findings in predicting thrombectomy outcomes [19]. However, to our knowledge, there are no studies using an established and easily obtainable scoring system such as the CHA_2DS_2-VASc score to predict functional outcomes following mechanical thrombectomy.

Recent studies have shown that the CHA_2DS_2-VASc score can be used to predict various outcomes beyond embolic stroke risk in patients with atrial fibrillation [20-24]. Furthermore, the CHA_2DS_2-VASc score has been shown to predict prognosis after stroke in patients with and without atrial fibrillation [25,26]. The CHA_2DS_2-VASc score includes many risk factors that lead to poor functional independence (an elevated mRS) following an AIS including hypertension, diabetes mellitus, and older age [27-30]. We therefore aimed to assess the utility of the CHA2DS2-VASc score in predicting short-term functional outcomes in patients who underwent mechanical thrombectomy for the treatment of LVO related AIS.

Methods

This is a single-center, nonrandomized, retrospective observational study performed at the University of Tennessee Medical Center, in Knoxville, Tennessee. The study was approved by the institutional review board (IRB) and conducted in compliance with the ethical standards of the responsible institution on human subjects as well as the Helsinki Declaration.

The study included patients with radiographic evidence of acute thromboembolic strokes who underwent mechanical thrombectomy. Charts were reviewed to calculate a CHA2DS2-VASc score and assess in-hospital, 30-day, and one-year mortality. Patients were divided into three groups based on the CHA2DS2-VASc scores as low-risk ≤ 2, intermediate risk 3-4, and high-risk ≥ 5. All patients between January 2018 and December 2020 were included in the study if they were ≥ 18 years of age, had an acute ischemic stroke confirmed by imaging, and had undergone mechanical thrombectomy.

A total of 448 patients were reviewed of which 312 patients had a confirmed thromboembolic stroke and underwent mechanical thrombectomy were selected and included in the study. Basic demographics, past medical history, use of thrombolytics, ejection fraction, stroke location, and degree of carotid stenosis were collected and analyzed for each patient. One-way ANOVA test was used for continuous variables and chi-square test was used for categorical variables. CHA2DS2-VASc scores were calculated on all the patients. The primary endpoint was the patient's modified-Rankin Score at 90-days. Secondary endpoints included mortality at 30-days and one-year mortality [27-30].

Results

A total of 312 patients with imaging confirmed thromboembolic stroke who underwent mechanical thrombectomy were included in this study. Patients were divided into three groups based on their calculated CHA2DS2-VASc score as either low-risk ≤ 2 (*n* = 97), intermediate risk 3-4 (*n* = 144), or high-risk ≥ 5 (*n* = 71) groups.

The baseline characteristics of the patient population are described in **Table 1**. The mean age of our study population was 70 years of age. One hundred and forty-nine patients were male (47%) and 163 were female (53%). A total of 129 patients

Table 1. Baseline characteristics of patients.

Characteristics	**Low CHA_2DS_2-VASc Score ≤ 2 (*n* = 97)**	**Intermediate CHA_2DS_2-VASc Score 3-4 (*n* = 144)**	**High CHA_2DS_2-VASc Score ≥ 5 (*n* = 71)**
Age (Yrs)	59.4 ± 12.29	72.15 ± 11.98	80.55 ± 7.41
Sex			
Male	60 (61.86%)	63 (43.75%)	26 (36.62%)
Female	37 (38.14%)	81 (56.25%)	45 (63.38%)
Medical history			
Diabetes Mellitus	6 (6.19%)	40 (27.77%)	37 (52.11%)
Hypertension	49 (50.51%)	117 (81.25%)	66 (92.95%)
Chronic systolic heart failure	5 (5.15%)	15 (10.42%)	14 (19.72%)
Chronic diastolic heart failure	21 (21.65%)	50 (34.72%)	35 (49.29%)
Previous Stroke/TIA	0 (0%)	21 (14.58%)	40 (56.33%)

Coronary artery disease	2 (2.1%)	36 (25%)	28 (39.44%)
Hyperlipidemia	27 (27.83%)	71 (49.30%)	45 (63.38%)
Peripheral arterial disease	1 (1.03%)	7 (4.86%)	10 (14.08%)
Chronic kidney disease	6 (6.19%)	16 (11.11%)	10 (14.08%)
Atrial fibrillation	15 (15.46%)	53 (36.81%)	33 (46.48%)
Smoker	49 (50.51%)	55 (38.19%)	18 (25.35%)
Obstructive sleep apnea	4 (4.12%)	7 (4.86%)	2 (2.82%)
Patent foramen ovale	6 (6.19%)	2 (1.39%)	1 (1.41%)
Ejection fraction (EF)	58.2 ± 9.81	56.68 ± 11.99	53.87 ± 14.52
BMI (kg/m^2)	27.35 ± 5.45	28.38 ± 5.94	27.95 ± 6.43
tPA given	41 (42.27%)	61 (42.36%)	27 (38.02%)
Stroke location			
ACA	0	0	0
MCA	65 (67.01%)	90 (62.5%)	47 (66.20%)
PCA	2 (2.1%)	5 (3.47%)	2 (2.82%)
ICA	5 (5.15%)	13 (9.03%)	6 (8.45%)
Basilar	3 (3.1%)	8 (5.55%)	6 (8.45%)
Vertebral	3 (3.1%)	0	0
Cerebellar	0	2 (1.39%)	0
Multiple vessels	15 (15.46%)	26 (18.05%)	10 (14.08%)
Degree of carotid stenosis			
None	55 (56.70%)	79 (54.86%)	28 (39.44%)
<50%	7 (7.22%)	16 (11.11%)	12 (16.90%)
50-69%	2 (2.1%)	6 (4.17%)	15 (21.13%)
≥70%	8 (8.25%)	13 (9.03%)	4 (5.63%)
Totally occluded	25 (25.77%)	30 (20.83%)	12 (16.90%)

Abbreviations: TIA: Transient Ischemic Attack; BMI: Body Mass Index; tPA: Tissue Plasminogen Activator; ACA: Anterior Cerebral Artery; MCA: Middle Cerebral Artery; PCA: Posterior Cerebral Artery; ICA: Internal Carotid Artery.

Variables are expressed as no (%) or mean ± standard deviation.

(41%) received thrombolytics prior to undergoing mechanical thrombectomy. As expected, the primary stroke location was the middle cerebral artery in the majority (65%, *n* = 202).

Patients in the high-risk group had a higher 90-day mRS (4.48) when compared to those patients in the intermediate (mRS 3.82) or low-risk groups (mRS = 2.57). This difference was statistically significant between the high-risk and low-risk groups (*p*-value <0.0001) as well as between intermediate and low-risk groups (*p*-value <0.001) (**Figure 1**). There was no statistically significant difference between the intermediate and high-risk groups (*p*-value 0.075) (**Figure 1**). In-hospital and 30-day mortality was higher in patients in the intermediate risk group (28.17%) and high-risk group (31.94%) when compared to those patients in the low-risk group (16.49%). This difference was statistically significant (p-value = 0007 and 0.07 respectively; **Figure 2** and **Table 2**). One-year mortality was also significantly higher in the high-risk group (12.68%) compared with the intermediate (3.46%, *p*-value = 0.01) and low-risk groups (4.12%, *p*-value = 0.04) (**Figure 2** and **Table 2**).

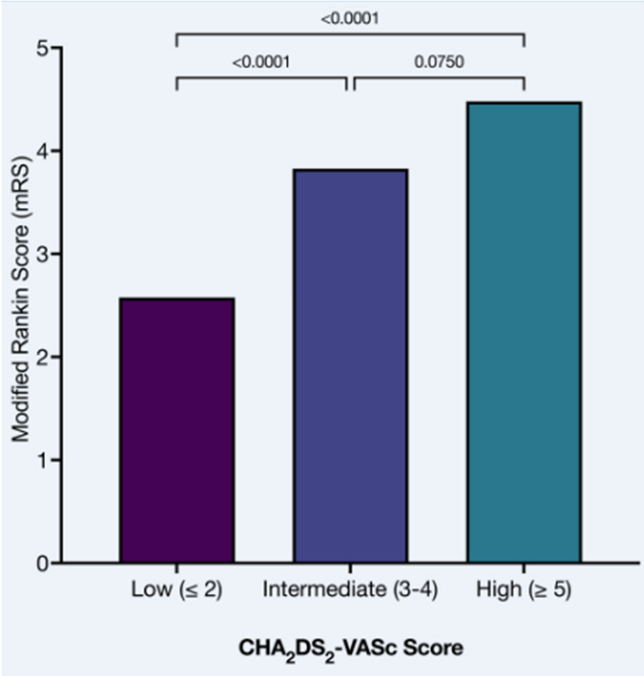

Figure 1. Comparing modified Rankin scores for patients with low, intermediate, and high risk CHA_2DS_2-VASc Score groups.

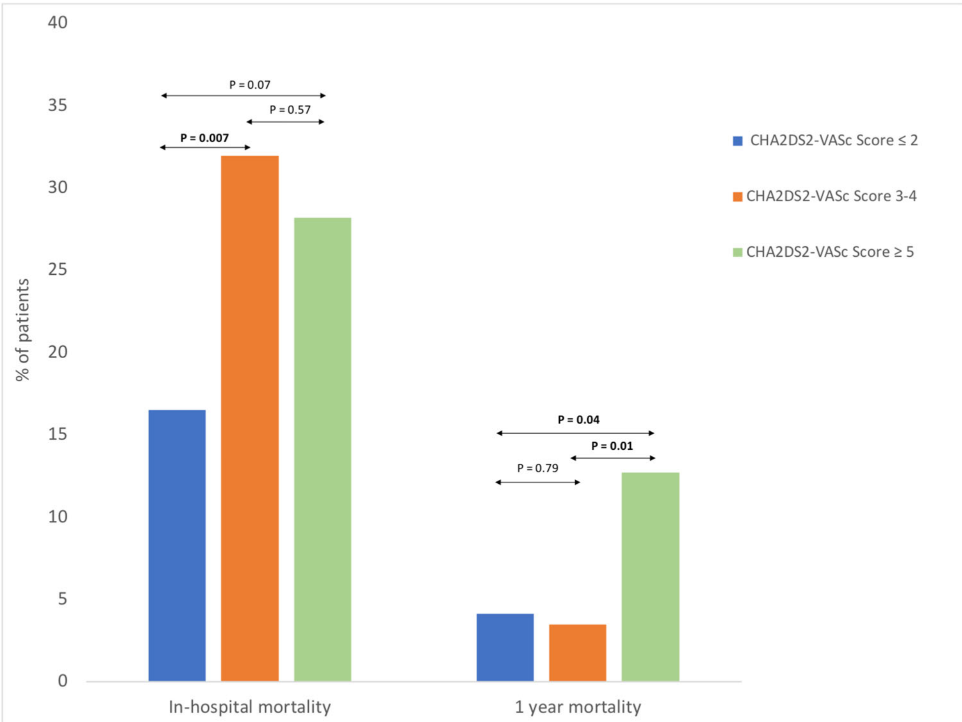

Figure 2. Comparing in-hospital and one year mortality for patients with low, intermediate, and high risk CHA_2DS_2-VASc Score groups.

Table 2. Clinical outcomes of patients with low, intermediate, and high risk CHA_2DS_2-VASc Scores.

Clinical Outcomes	**Low CHA_2DS_2-VASc Score ≤ 2** (*n* = 97)	**Intermediate CHA_2DS_2-VASc Score 3-4** (*n* = 144)	**High CHA_2DS_2-VASc Score ≥ 5** (*n* = 71)	**P Value**
Mortality				
In-hospital	16 (16.49%)	46 (31.94%)	20 (28.17)	0.026
1 Year	4 (4.12%)	5 (3.47%)	9 (12.68%)	0.017
Modified Rankin Score (mRS)	2.57 ± 2.21	3.82 ± 2.06	4.48 ± 1.82	<0.001

Discussion

The management of AIS secondary to LVO has greatly evolved with the utilization of mechanical thrombectomy. Studies have demonstrated that patients undergoing endovascular therapy have better outcomes and greater rates of functional independence compared to patients treated with medical therapy alone [2-7,31]. Studies have also shown that mechanical thrombectomy provides benefit up to 24 hours after a LVO related AIS [19,31]. Importantly, patients presenting with high pre-stoke functional disability and elevated pre-stroke mRS have similar clinical outcomes with mechanical thrombectomy compared to patients with pre-stroke independence [32,33]. Despite the known outcome benefits of mechanical thrombectomy, interventional proceduralist must utilize both clinical judgement and neuroimaging findings to predict post-thrombectomy functional outcomes and mortality. To help with this prediction, scoring systems have been developed to use in the clinical setting prior to performing mechanical thrombectomy. Studies have identified various neuroimaging findings on both computerized tomography (CT) scan and magnetic resonance imaging (MRI), that can functional outcome and response to endovascular therapy [34-43]. While initially developed to determine stroke severity and predict functional outcome following an AIS, the Alberta Stroke Program Early CT Score (ASPECTS) has also been used to predict outcomes following mechanical thrombectomy [35-39]. More recently, in addition to neuroimaging parameters, outcome prediction scores have also included clinical parameters [18,44-46]. The TICI-ASPECTS-glucose (TAG) score, which includes two neuroimaging scores (TICI and ASPECTS) and glucose level, has been shown to predict symptomatic intracranial hemorrhage in patients receiving endovascular therapy [45]. The GADIS score combines cerebral infarct volume on MRI following endovascular therapy with gender, age, diabetes history, and current smoking status to help in early short-term prognostication [18,46]. However, experts have criticized certain aspects of the GADIS score, specifically the need for a post-intervention MRI [47]. The THRIVE score was one of the first scoring systems to use clinical data to predict functional outcome in patients presenting with acute basal artery occlusions treated with mechanical thrombectomy [17]. Patients with high THRIVE scores following thrombectomy, including those with hypertension, atrial fibrillation, hyperglycemia, elevated NIH scores, and older age, are at increased risk for poor functional outcomes and all-cause mortality [17]. Despite the recent advancements in endovascular therapy, scoring systems that focus on easily obtained clinical data to predict functional outcomes following mechanical thrombectomy are limited. The goal of our study was to determine the utility of the CHA_2DS_2-VASc score in predicting functional outcomes of patients with LVO related AIS undergoing mechanical thrombectomy.

Our decision to use the CHA_2DS_2-VASc score to predict functional outcomes following mechanical thrombectomy was based on three main factors. First, the CHA_2DS_2-VASc score can be easily calculated from a quick review of past medical history. Second, studies have established the validity of the CHA_2DS_2-VASc score to predict stroke as well as poor cardiovascular outcomes in both patients with and without atrial fibrillation [22-26]. Lastly, the CHA_2DS_2-VASc score includes some of the same risk factors – hypertension older age, and diabetes - that lead to poor functional outcomes (such as elevated mRS) following an AIS [27-30]. In our cohort of 312 patients presenting with LVO related to AIS, the relationship between CHA_2DS_2-VASc score and mRS were directly proportional. Thus, patients with a higher CHA_2DS_2-VASc score prior to mechanical thrombectomy were more likely to have higher mRS at 90 days post-thrombectomy and therefore, worse functional independence. At 90 days following mechanical thrombectomy, patients with a CHA_2DS_2-VASc score of 5 or greater were more likely to have moderate to severe disability, required walking assistance, and were unable to attend to bodily needs without assistance compared to patients with lower CHA_2DS_2-VASc scores. Furthermore, patients with pre-thrombectomy CHA_2DS_2-VASc scores ≥ 5 are at higher risk of 1 year mortality following endovascular therapy.

As previously discussed, all patients presenting with LVO related AIS benefit from mechanical thrombectomy including those with multiple comorbidities and pre-stroke dependence [32,33]. Therefore, the purpose of our study was not to discourage interventional proceduralist from performing mechanical thrombectomy in patients with high CHA_2DS_2-VASc scores. Rather, this study focused on using a well-known, simple scoring system to predict poor functional outcomes in patients undergoing mechanical thrombectomy and assist providers with post-procedural care planning. For example, providers can plan for the possibility of prolonged hospitalizations and more intensive rehabilitation in patients with elevated pre-thrombectomy CHA_2DS_2-VASc scores. Furthermore, proceduralists can have important conversations with patients and their families regarding their expectations about functional outcomes following mechanical thrombectomy. While not addressed in this study, another potential use of estimating pre-procedural CHA_2DS_2-VASc score is procedural planning and predicting risk of mechanical thrombectomy failure. Given that the CHA_2DS_2-VASc score includes many of the same risk factors that lead to thrombectomy failure such as pre-existing atherosclerosis, it could potentially be used to identify patients who are at higher risk of failure [48-55]. However, additional research is needed to further investigate this hypothesis.

Our study aimed to assess the utility of the CHA_2DS_2-VASc score in predicting outcomes in patients that undergo mechanical thrombectomy for acute ischemic stroke. There are a plethora of studies demonstrating the benefits of rapid cerebral reperfusion particularly with the use of mechanical thrombectomy. Our study suggests that the higher the CHA_2DS_2-VASc score, higher the modified Rankin score at 90-days, with similar linear relationship with in-hospital, 30-day, and one-year mortality in patients with higher CHA_2DS_2-VASc score.

Limitations

The main limitation of our study was data collection in a retrospective manner at a single center. In addition, only patients with a 90-day mRS and at least one year follow-up was included in this study. A randomized controlled study would alleviate these limitations.

Conclusion

CHA_2DS_2-VASc score is a simple tool which can quickly be assessed to predict patient outcomes following mechanical thrombectomy. Using this easy to calculate bedside pre-procedural score can help assess patient outcomes and provide answers regarding family's expectations. The CHA_2DS_2-VASc score can be useful in predicting functional outcomes in patients undergoing mechanical thrombectomy.

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