Acute Ischemic Stroke with Vessel Occlusion—Prevalence and Thrombectomy Eligibility at a Comprehensive Stroke Center

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Introduction: Endovascular thrombectomy (ET) for acute ischemic stroke (AIS) caused by large vessel occlusion (LVO) can prevent severe disability and mortality. There is currently limited data on the epidemiology of LVO strokes and ET eligibility. We aim to determine the incidence of intracranial vessel occlusion (IVO) strokes eligible for ET per 2018 American Heart Association (AHA) guidelines and characteristics of an AHA ineligible population at a comprehensive stroke center (CSC). *Methods:* Retrospective chart review of all consecutive AISs at a CSC between November 2014 and February 2017. Demographic, clinical, and radiographic data were analyzed to determine ET eligibility per AHA guidelines and characteristics of ineligible patients were investigated. *Results:* Twenty-four percent of AIS harbor an IVO. Thirty percent of IVO strokes and 47% of anterior circulation LVO strokes are thrombectomy eligible per AHA guidelines. Most common reasons for thrombectomy ineligibility among IVO strokes are presence of IVO other than anterior circulation LVO (35%, n = 224), presence of large stroke burden (15%, n = 93), baseline modified Rankin scale greater than or equal to 2 (14%, n = 89), and NIHSS score less than 6 (15%, n = 96). *Conclusions:* At a CSC, 1 in 4 AISs harbor an IVO. Seven in 100 acute ischemic strokes, 3 in 10 strokes with vessel occlusion, and 1 in 2 strokes with internal carotid or middle cerebral artery M1 occlusion are thrombectomy eligible per AHA 2018 guidelines. These data highlight that current guidelines render a majority of strokes thrombectomy ineligible and a large window of opportunity exists for clinical investigation.

Key Words: Stroke—ischemic stroke—epidemiology—thrombectomy—guideline—eligibility—neurointervention

Introduction

Endovascular thrombectomy is the standard of care for acute ischemic stroke (AIS) caused by an anterior circulation large vessel occlusion (ACLVO), preventing severe disability and mortality.[1,2] Thrombectomy eligibility has been previously estimated to be approximately 6%-7% of AIS at a comprehensive stroke center (CSC).[3,4] Current data on the incidence of large vessel occlusion strokes, thrombectomy eligibility and reasons for ineligibility per updated American Heart Association (AHA) 2018

Abbreviation: AIS, acute ischemic stroke; CT, computed tomography; ICA, internal carotid artery; MCA, middle cerebral artery; mRS, modified Rankin scale; NIHSS, National Institutes of Health Stroke Scale; LVO, large vessel occlusion; IVO, intracranial vessel occlusion

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guidelines is lacking. Analysis of AIS is required to guide resource allocation and stroke care network development. Characterization of reasons for ineligibility will identify potential windows of opportunity for treatment expansion.

Methods

After Institutional Review Board approval, a retrospective chart review of all AIS discharges at our comprehensive stroke center was performed between November 2014 and February 2017. Demographic features (age, sex, baseline modified Rankin scale [mRS] score), stroke characteristics (National Institute of Health Stroke Scale [NIHSS] score, time from last known well), and radiographic data (computed tomography [CT] and CT angiography or magnetic resonance [MR] angiography, or digital subtraction angiography [DSA] in treated patients) were recorded by a vascular neurologist. All consecutive AISs underwent vessel imaging (CTA or MRA or DSA) to identify the presence of an intracranial vessel occlusion (IVO- internal carotid or middle cerebral artery [MCA M1, segment 1, 2, or 3], anterior cerebral artery [segment 1 or 2], vertebral or basilar artery, posterior cerebral artery). Determination of stroke burden was performed using ASPECTS (analyzed by a vascular neurologist) and automated ischemic core volume measurement (RAPID, IschemaView, Inc) when CT perfusion or MRI were available. During the given time period, CT perfusion and/ or MRI were performed for all internal carotid or MCA M1 occlusions in the 6-24-hour time period. Mechanical thrombectomy eligibility was evaluated per AHA 2018 guidelines.[1] In the 0-6-hour time window, patients with NIHSS score greater than or equal to 6, ASPECTS greater than or equal to 6, ACLVO (internal carotid or MCA M1 segment), and baseline mRS 0-1 were deemed thrombectomy eligible. In the 6-24-hour time window, patients meeting DAWN and/ or DEFUSE-3 trial criteria (applied upto 24 hours, instead of 16 hours) were deemed thrombectomy eligible [NIHSS score ≥6, ACLVO, ischemic core volume <70 mL with presence of DAWN or DEFUSE-3 trial defined clinical-core or radiographic mismatch, and baseline mRS 0-1]. Reasons and characteristics of AHA ineligible AISs were investigated. Incidence of AHA eligibility and reasons for ineligibility have been described as percentages using relevant denominators—all AISs and AIS with IVO or ACLVO (total and ineligible cohorts).

Results

Twenty-four percent (n = 639) of the 2667 AISs discharged during the study period harbored an IVO. Of those, 65% (n = 415) had an ACLVO (internal carotid or MCA M1), 16% had an MCA M2 (n = 101) occlusion and 15% had a vertebro-basilar (n = 96) occlusion (Fig 1). Fifty percent (n = 320) of the 639 IVOs and 54% (n = 224) of the 415 ACLVOs presented within 6 hours of time last known well. In the 0-6-hour versus 6-24-hour time window, AHA eligibility for all AIS (≤6 hours = 1587, >6 hours = 1080) was 8.3% versus 5.7%. Similarly, AHA eligibility for AIS with IVO (0-6 hours = 320, 6-24 hours = 319) and AIS with ACLVO (0-6 hours = 224, 6-24 hours = 191) was 38.2% versus 21.1% and 58.9% versus 32.4%, respectively. Forty one percent (n = 39) of vertebro-basilar occlusion strokes presented within 8 hours of last known well. Overall, 7.3% of all AIS, 30.3% of AIS with IVO, and 46.9% AIS with ACLVO were AHA eligible in the 0-24-hour time window.

At our CSC, 56.1% (n = 1496) of all AISs at our CSC were transferred from a primary stroke center or a referral facility. Anterior circulation LVO was found in 19.8% (n = 296) of transfers versus 10.2% (n = 119) of direct admissions (n = 1171; $P \leq .01$). AHA eligibility among transferred anterior circulation LVO strokes was 47.9% (n = 142), compared to 43.7% (n = 52) among direct admissions ($P = .42$).

Most common reasons for thrombectomy ineligibility among IVO strokes are presence of non-ACLVO (35%, n = 224), large stroke burden (ASPECTS <6 or ischemic core volume >70 mL; 15%, n = 93), baseline mRS greater than or equal to 2 (14%, n = 89) and NIHSS score less than 6 (15%, n = 96). Detailed reasons for ineligibility in IVO (Table 1) and ACLVO (Table 2) have been depicted in Figure 2.

Discussion

The main findings of our study are that 24% of all AISs harbor an IVO and that thrombectomy eligibility per 2018 AHA guidelines among all AIS, AIS with IVO, and AIS with ACLVO is 7.3%, 30.3%, and 46.9%, respectively. Our study provides the most updated analysis of thrombectomy eligibility (including late window strokes) and reasons for ineligibility in the 0-24-hour time window at a CSC. These data have important implications for thrombectomy utilization at a CSC − about 7 in 100 of all AIS, 1 in 3 of all AIS with vessel occlusion, and 1 in 2 of all ACLVO strokes will be thrombectomy eligible per AHA guidelines. Extrapolating our AHA eligibility data to 800,000 strokes occurring in the US annually,[5] approximately 56,000 AISs maybe thrombectomy eligible per AHA guidelines. Smith et al report that thrombectomy was performed in only 3.3% of all ischemic strokes across the United States in 2016,[6] which represents less than half of the AHA eligible ischemic strokes (7.3%) reported in our study. This suggests that stroke care resources need to be optimized urgently to maximize the potential of thrombectomy.

Despite presence of an IVO, 70% patients were thrombectomy ineligible. Subgroups of interest currently being studied in the context of clinical trials include patients with a large stroke burden (ASPECTS <6 or ischemic core >70 mL) at presentation (3.5% of all AIS; 21% of all

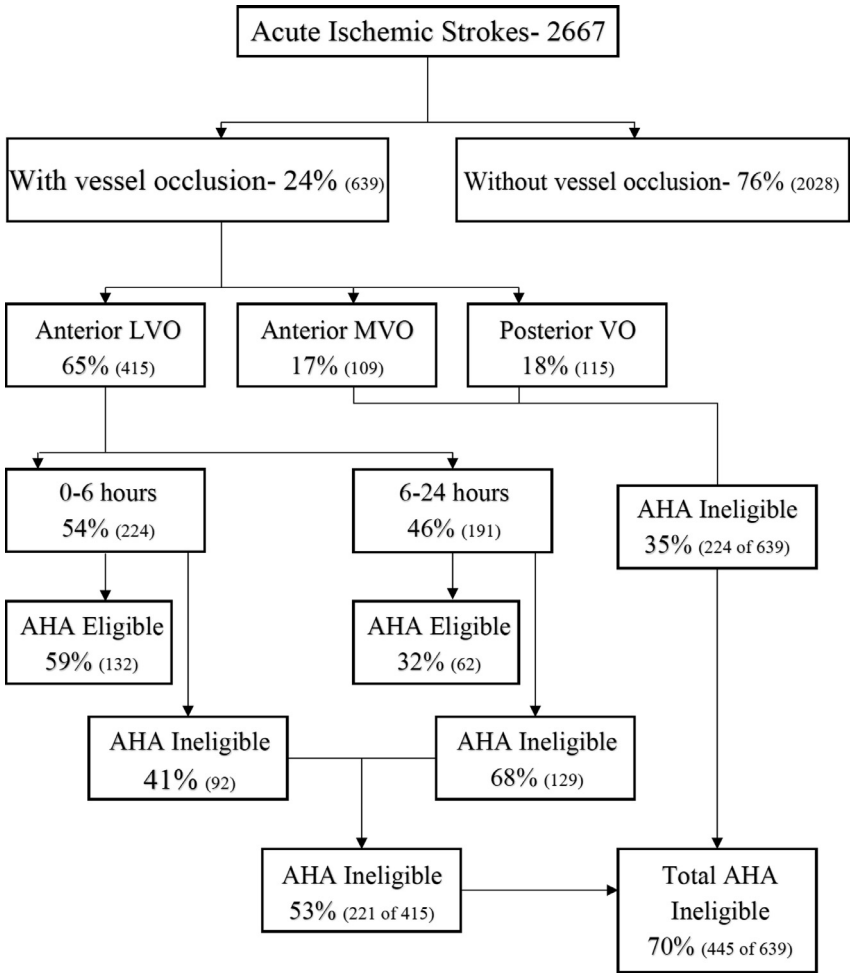

Figure 1. *Flow chart.*

Table 1. *Reasons for guideline ineligibility*

Reasons	Among all IVO Strokes (639)	Among Ineligible IVO Strokes (445)
NIHSS score <6	15% (96)	22% (96)
Large Stroke Burden	15% (93)	21% (93)
Baseline mRS ≥2	14% (89)	20% (89)
MCA M2	16% (101)	23% (101)
ACA A1	.4% (3)	.6% (3)
Vertebro-basilar	15% (96)	22% (96)
PCA	1.5% (10)	2% (10)

Abbreviations: ACA A1, anterior cerebral artery A1 segment; IVO, intracranial vessel occlusion; MCA M2, middle cerebral artery M2 segment; mRS-modified Rankin scale; NIHSS, National Institutes of Health Stroke Scale; PCA, posterior cerebral artery.

ineligible AIS with IVO; 42% of all ineligible AIS with ACLVO; RCTs- IN EXTREMIS,[7] TENSION[8]) and patients with low NIHSS (<6) score (2.7% of all AIS; 16% of all ineligible AIS with IVO; 16% of all ineligible AIS with ACLVO; RCTs—IN EXTREMIS,[7] ENDO LOW). The BEST trial[9] (0-8 hours) and the BAOCHE trial[10] (6-24 hours) in China are exploring the benefit of thrombectomy over medical management in basilar artery occlusion (3.2% of all AIS; 19% of all ineligible AIS with IVO). Another important subgroup is MCA M2 occlusion strokes (3.7% of all AIS; 23% of all ineligible AIS with IVO). Patients with baseline mRS greater than or equal to 2 contribute to 20% of ineligible AIS with IVO cohort. Assuming future thrombectomy guidelines are more inclusive and recommend thrombectomy for patients with low NIHSS (ACLVO only), large stroke burden and MCA M2 or Vertebro-basilar occlusion, thrombectomy eligibility for all AIS would potentially increase from 7.3% to 19%. Proportion of AISs with IVO was higher in the transfer population, but AHA eligibility for thrombectomy in transfers versus direct admissions was similar among IVO and ACLVO stroke subpopulations.

Our study provides important data for future randomized clinical trials. The frequency of individual AIS subgroups of interest (low NIHSS, large stroke burden, and MCA-M2 occlusion) is not high and retrospective data suggest moderate treatment effect of thrombectomy due to severity and/ or natural history considerations. Assuming a 10% treatment effect of thrombectomy (less than half

Table 2. *Reasons for guideline ineligibility among anterior circulation LVO*

Reasons	Anterior circulation LVO (Total = 415)					
	0-6 hours		6-24 hours		0-24 hours	
	Total (224)	Ineligible (92)	Total (191)	Ineligible (129)	Total (415)	Ineligible (221)
NIHSS score <6	8% (18)	20% (18)	9% (18)	14% (18)	9% (36)	16% (36)
Large Stroke Burden (per time window of presentation)	ASPECTS <6		Core >70 mL			
	17% (39)	42% (39)	28% (54)	42% (54)	22% (93)	42% (93)
			Less than adequate mismatch			
			17% (32)	25% (32)		
Baseline mRS ≥2	17% (38)	41% (38)	16% (31)	24% (31)	17% (69)	31% (69)

Abbreviations: LVO, large vessel occlusion; mRS, modified Rankin scale; NIHSS, National Institutes of Health Stroke Scale.

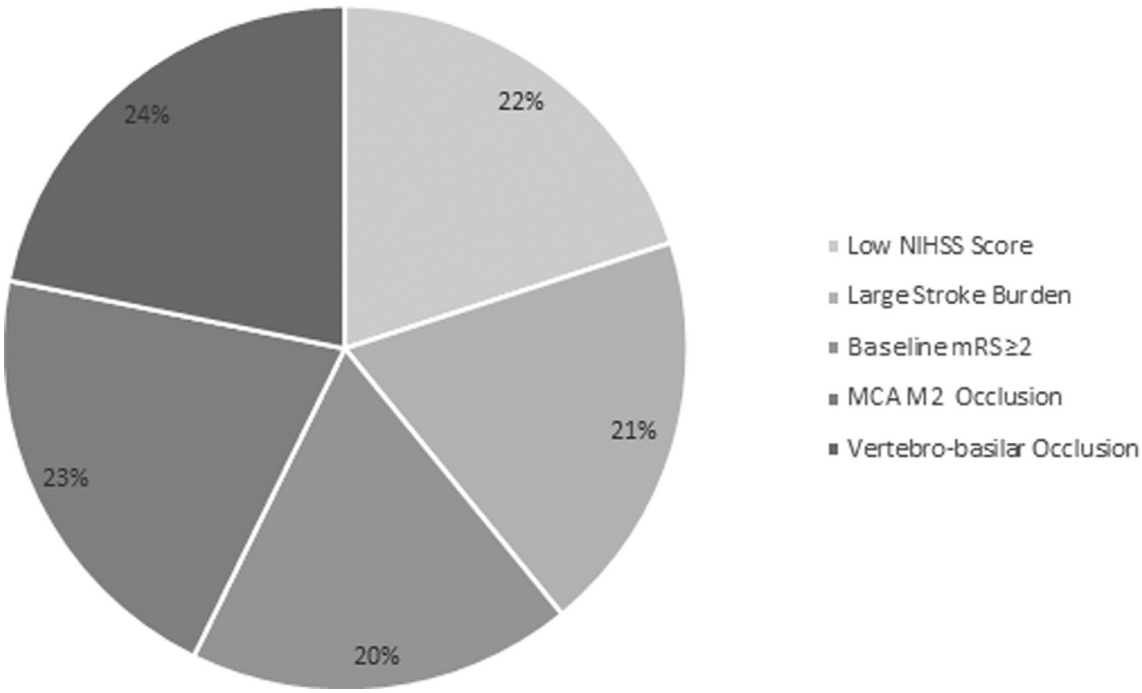

Figure 2. *Reasons for thrombectomy ineligibility among acute ischemic strokes with intracranial vessel occlusion (n = 445).*

of most anterior circulation thrombectomy trials) concerning relevant endpoints and 80% power, a sample size of 712, 774, and 602 would be required to study the effect of thrombectomy in LVO strokes with ASPECTS less than or equal to 5, NIHSS score less than or equal to 5, and MCA-M2 occlusions, respectively. By estimating frequency of these subgroups, our study also informs regarding the amount of time needed to enroll patients in future trials at a comprehensive stroke center.

One of the strengths of our study is that we included consecutive AISs presenting to our CSC and have confirmed occlusion location on CT or MR angiography or DSA. Further, we provide estimates of AHA eligibility among transfer versus direct admissions and find similar rates of AHA eligibility among anterior circulation LVO strokes. Our study is limited by its retrospective nature. Analysis at a single tertiary care center serving a specific geography of patients with a large referral base may limit generalizability of our results. We acknowledge that at a CSC, transfers from PSC leads to enrichment of acute strokes with vessel occlusion. However, our data are in keeping with previously reported estimates of large vessel occlusion strokes[11] and reflect the patient profile at a large CSC. Nonetheless, similar analyses in larger, multicenter datasets are necessary to confirm our findings.

Conclusions

At a CSC, 1 in 4 AISs harbor an IVO. Seven in 100 AISs, 3 in 10 strokes with vessel occlusion, and 1 in 2 strokes

with internal carotid or middle cerebral artery M1 occlusion are thrombectomy eligible per AHA 2018 guidelines. These data highlight that current guidelines render a majority of strokes thrombectomy ineligible and a large window of opportunity exists for clinical investigation.

Data Sharing

The data utilized to prepare this manuscript may be shared upon reasonable request.

Contributorship Statement

Conception and design: Jadhav. Acquisition of data: Desai. Analysis and interpretation of data: All. Drafting the article: Desai, Jadhav. Critically revising the article: All. Administrative/technical/material support: All. Study supervision: Jadhav.

Disclosures

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Declaration of Competing Interest

No authors have a competing interest with respect to this manuscript and its contents.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jstrokecerebrovasdis.2019.104315.

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