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Higher intracranial positioning of an 8 Fr guide catheter improves efficacy of aspiration thrombectomy in large vessel occlusion stroke

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ABSTRACT

Background Higher positioning of a large bore guide catheter during endovascular thrombectomy (EVT) is hypothesized to potentially improve thrombectomy success.

Objective To evaluate the safety and efficacy of intracranial guide catheter placement during EVT using a multicenter database.

Methods We reviewed data on consecutive patients undergoing EVT for anterior circulation large vessel occlusion (LVO) at three comprehensive stroke centers between October 2019 and December 2022. Participants were allocated to one of two cohorts: intracranial (n=141)—guide catheter tip positioned in the petrous carotid or further distal; and control (n=285)—guide catheter tip below the petrous carotid. Primary outcome was excellent reperfusion (Thrombolysis in Cerebral Ischemia (TICI) 2c or better), first pass effect (TICI 2c or better after one pass), and arterial access to final reperfusion time. The unpaired t-test, Mann-Whitney U test, and Fisher's exact test were used to compare the means, medians and proportions of the two groups, respectively. P values & lt;0.05 were considered statistically significant two cohorts.

Results A total of 426 patients were included in the analysis. Patients with guide catheter location in the petrous segment or further distal had a significantly higher first-pass effect (111/284, 39.1% vs 37/141, 26.2%, P=0.009). There was no significant difference in final excellent recanalization rates between groups (202/285, 70.9% vs 92/141, 65.2%, P=0.266). Furthermore, intracranial positioning of the guide catheter was associated with significantly shorter time to final recanalization (median 21.0 (13.0–38.0) min vs 30.0 (17.0–48.0) min, P<0.001).

Conclusion Positioning a large bore guide catheter in the petrous segment or further distal resulted in a significantly higher rate of first pass effect, faster procedural times, and equivalent final excellent reperfusion rates compared with more proximal guide catheter placement for patients with anterior circulation LVO.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Previous studies have indicated that distal placement of guide catheters in endovascular thrombectomy (EVT) might improve procedural outcomes, such as first pass success and final reperfusion rates. However, evidence from larger cohorts and comprehensive multicenter analyses was lacking, particularly regarding the impact of guide catheter positioning on procedural efficiency and outcomes.

WHAT THIS STUDY ADDS

⇒ This study provides robust evidence from a multicenter database showing that positioning a large bore guide catheter in the petrous segment or further distal significantly improves the first pass effect, reduces procedural time, and improves final reperfusion rates. It confirms that distal placement is associated with faster recanalization and supports the hypothesis that more distal catheter placement enhances EVT outcomes.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings suggest that adopting distal guide catheter placement could enhance EVT effectiveness and efficiency. This might influence clinical practice guidelines by promoting distal positioning as a preferred technique to improve first pass success and reduce procedure duration. Future research might focus on validating these findings in randomized controlled trials and exploring the implications for other EVT practices.

INTRODUCTION

Large vessel occlusion (LVO) contributes to a disproportionate number of deaths and disability after acute ischemic stroke.[1] Several factors are associated with good clinical outcome following endovascular thrombectomy (EVT), including younger age,[2 3] good collateral status,[2] lower baseline National Institute of Health Stroke Scale (NIHSS) score,[2 3] decreased time to intervention,[4] and first pass success.[5]

While EVT has shown to be effective in treating LVO, additional research is needed to determine techniques that may contribute to improved

outcomes. Several retrospective studies suggest that intracranial guide catheter position may influence LVO outcomes,[6–8] but data from larger cohorts are needed to further understand ideal guide catheter placement.

Studies have found increased rates of complete recanalization in patients with distal catheter placement compared with those with proximal placement.[6–9] Distal catheter placement has also been associated with increased rates of first pass effect.[6–8 10] Several smaller studies have suggested shorter procedure time in patients with distal catheter placement,[6–8] but one prospective study suggested no significant difference in arterial puncture to reperfusion time between distal and proximal catheter placement.[10]

We explore the effect of guide catheter placement in aspiration thrombectomy procedures through a multicenter retrospective study on prospectively collected data using a large bore 8 French guide catheter system.

METHODS

A retrospective analysis was conducted of prospectively maintained databases of EVT patients. Eligible patients were >18 years old and presented to one of three comprehensive stroke centers between October 2019 and December 2022 with anterior circulation LVOs in the internal carotid artery (ICA) terminus, M1 segment of the middle cerebral artery (M1), and M2 segment of the middle cerebral artery (M2). Patients with posterior circulation occlusion and tandem occlusion in the anterior circulation were excluded. The study protocol was approved by the institutional review boards of the corresponding centers.

Patients were divided into two cohorts: distal or proximal, based on guide catheter position during the EVT, which was confirmed by angiography review. The positioning of the guide catheter was influenced by tortuous anatomy and trackability. When possible, operators aimed to place the guide catheter as distal as possible. The distal cohort was confirmed to have the guide catheter in the petrous segment of the ICA or further distal. The guide catheter was positioned in the distal cervical ICA or more proximal for the proximal group.

Baseline demographics, including age, gender, and race, were collected. Baseline functional status was measured by modified Rankin Scale (mRS) score and the severity of baseline neurologic deficits was measured by the NIHSS score. The data also include procedure details, such as access site, the type of guide catheter used, procedure time, and final reperfusion status.

The primary outcomes of this study were procedural success, rate of final excellent reperfusion, first pass effect (FPE), and arterial access to final reperfusion time. Final excellent reperfusion was defined as modified Thrombolysis in Cerebral Ischemia (mTICI) 2c or better while FPE was defined as mTICI 2c or better after one pass. Secondary analysis was conducted to compare the prevalence of adverse events between groups, including symptomatic intracranial hemorrhage (sICH) and emboli to new territory. Final reperfusion was also compared between groups.

Basic descriptive statistics were used to report baseline characteristics. Data were presented as mean (SD) or median (IQR) and percentage (counts). The unpaired t-test, Mann-Whitney U test, and Fisher's exact test were used as the data were not normally distributed. All analyses were carried out on Minitab. Statistical significance was set at $P<0.05$.

RESULTS

A total of 426 patients were included in the analysis. Of these patients, 285 (66.9%) were included in the distal cohort and 141 (33.1%) were included in the proximal cohort. An increased proportion of the distal cohort presented with a baseline mRS score of 0 compared with the proximal cohort (66.8% vs 50.4%, P=0.005). Other baseline characteristics, including gender, age, race, time from last known well, NIHSS score, and Alberta Stroke Program Early CT Score (ASPECTS) were comparable between the cohorts (table 1).

Table 1 Baseline characteristics of study patients

Characteristics	Intracranial guide catheter position	Cervical guide catheter position	P value
Female, % (n/N)	50.5% (144/285)	53.9% (76/141)	0.537
Age, median (IQR)	69.2±15.2	68.0±16.0	0.550
Race, % (n/N)			
Black or African American	22.6% (30/133)	44.9% (35/78)	0.145
Native Hawaiian or Pacific Islander	0.8% (1/133)	0.0% (0/78)	>0.999
White	75.2%	65.4% (51/78)	0.155
Other	1.5% (2/133)	2.6% (2/78)	0.627
Time last known well, h, mean±SD	7.1±5.3	8.6±6.2	0.102
NIHSS score, median (IQR)	16 (12–21)	17 (13–22)	0.156
ASPECTS, median (IQR)	8 (7–10)	9 (7–10)	0.590
Pre-stroke mRS score, % (n/N)			
mRS score 0	66.8% (123/184)	50.4% (59/117)	**0.005**
mRS score ≤2	89.7% (165/184)	89.7% (105/117)	0.69

ASPECTS, Alberta Stroke Program Early CT Score ; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale.

Access through the femoral artery was more common for the distal group than for the proximal group (99.6% vs 95.5%, P=0.011). Occlusion location and EVT technique were comparable between groups (table 2). The Imperative Care Zoom 88 guide catheter was used most frequently for the distal group (n=227, 80%) while the Penumbra Neuron Max guide catheter was used most frequently for the proximal group (n=69, 49%) (table 3).

The distal group had a significantly higher FPE than the proximal group (111/284, 39.1% vs 37/141, 26.2%, P=0.009). Time from arterial puncture to revascularization (mTICI ≥2b) was significantly shorter for the distal group compared with the proximal group (median (IQR) 21.0 (13.0–38.0) min vs 30.0 (17.0–48.0) min, P<0.001 (table 4). However, rates of final

Table 2 Procedure characteristics in both treatment groups

Characteristics	Intracranial guide catheter position	Cervical guide catheter position	P value
Access site, % (n/N)			
Femoral	99.6% (231/232)	95.5% (127/133)	**0.011**
Radial	0.4% (1/232)	3.8% (5/133)	**0.026**
Direct carotid access	0.0% (0/232)	0.8% (1/133)	0.364
Occlusion location, % (n/N)			
ICA terminus	24.2% (69/285)	32.4% (46/142)	0.083
M1 - MCA	62.8% (179/285)	56.3% (80/142)	0.208
Proximal M2 - MCA	13% (37/285)	11.3% (16/142)	0.246
Thrombectomy technique, % (n/N)			
ADAPT	87.6% (220/251)	83.8% (114/136)	0.353
Solumbra/stent retriever	12.4% (31/251)	16.2% (22/136)	0.353

ICA, internal carotid artery; MCA, middle cerebral artery.

Table 3 8Fr guide catheters used in both treatment groups

Characteristics	Intracranial guide catheter position	Cervical guide catheter position
Guide catheter model, N		
BMX	0	24
Cerebase	1	0
FlowGate	1	4
Infinity Plus	9	11
Neuron Max	22	69
TracStar	22	6
Walrus	4	13
Zoom 88	227	14

excellent reperfusion were not statistically different between the groups (202/285, 70.9% vs 92/141, 65.2%, P=0.266).

Rates of sICH and emboli to new territory were comparable between groups. Final reperfusion scores were also similar between the groups (table 4).

DISCUSSION

These data demonstrate that distal placement of large bore 088 guide catheters in the intracranial segment of the internal carotid artery during EVT for LVO stroke is safe and appears effective. Furthermore, distal placement is associated with significantly faster procedure times and a higher rate of FPE. This study is one of the largest multicenter cohort to examine the procedural impact of guide catheter placement during EVT. The significantly higher rate of FPE observed in our analysis is consistent with prior studies.[6 8–10] A prospective study conducted by Navia *et al* also found that distal guide catheter placement without crossing the occlusion resulted in an increased likelihood of achieving first pass effect compared with proximal guide catheter placement.[10] It should be noted that Navia *et al* used the ADAPT Registry, which only includes EVT data using the ACE68 aspiration catheter.[10] Smaller studies conducted by Milburn *et al* and Lee *et al* also showed increased rates of FPE following distal guide catheter placement, using an 088 guide catheter.[7 8]

We also observed significantly shorter procedure times for patients with distal guide catheter placement in comparison with patients with proximal catheter placement. This has been also suggested in prior smaller studies in the past.[6 8 9] Historically, biaxial and triaxial systems were used (including a guide catheter, intermediate catheter, distal access catheter) to build a 'tower of power' as a fundamental concept for a safe neurointerventional procedure.[11] However, the advent of long, large bore guide catheters has eliminated the need to use a multiaxial system to reach the intracranial segment of the ICA. More distal positioning of a large bore catheter in the intracranial segments of the ICA may be partially occlusive and lead to a flow arrest effect similar to balloon inflation with a balloon guide catheter, and therefore maximizes the thrombectomy efficacy.[12] This phenomenon might account for the higher FPE rates and shorter procedure times in the current study as previously demonstrated with the use of balloon guide catheters in EVT.[13 14] Furthermore, closer positioning of the guide catheter to the primary aspiration catheter may maximize aspiration effectiveness, as suggested by the shorter procedure times and higher FPE in the distal cohort.

Smaller studies conducted by Jeong *et al*[6], Milburn *et al*[7], and Lee *et al*[8] are consistent with the current study, demonstrating shorter procedure times for distal guide catheter placement EVT compared with proximal guide catheter placement EVT. A larger study conducted by Navia *et al* demonstrated lower median time from arterial puncture to reperfusion in the cohort with distal guide catheter positioning compared with the proximal cohort (37 vs 29 min).[10] A difference in access site might account for the inconsistency between the findings of the current study and that of Navia *et al*. All patients studied by Navia *et al* underwent femoral access. In the current study, a significantly higher percentage of patients in the distal cohort underwent femoral access compared with patients in the proximal cohort.[10] Femoral access may allow for better overall access support when navigating arch anatomy and tortuosity, which may allow for more distal placement of the guide catheter. A meta-analysis conducted by Joyal *et al* reported radial access to be associated with a slight increase in procedure time,[15] which might further exacerbate the difference in procedure time found in the current study. Radial access may result in increased procedure time due to multiple factors, including difficult access in tortuous anatomy, and less operator experience as it is a more recently developed technique for neurointerventional procedures.[16]

Table 4 Primary effectiveness and safety outcomes

Measure	Intracranial guide catheter position	Cervical guide catheter position	P value
Final excellent reperfusion, % (n/N)	70.9% (202/285)	65.2% (92/141)	0.266
First pass effect, % (n/N)	39.1% (111/284)	26.2% (37/141)	**0.009**
Access to mTICI ≥2b, median (IQR)	21 (13–38)	30 (17–48)	**0.003**
Access to procedure completion, min, median (IQR)	24 (13–49)	35 (20–60)	**<0.001**
sICH, % (n/N)	2.2% (5/232)	3.0% (4/133)	0.729
Intracranial hemorrhage, % (n/N)	20.7% (48/232)	15.0% (20/133)	0.210
Emboli to new territory, % (n/N)	0.9% (2/231)	2.3% (3/133)	0.360
Final Reperfusion, % (n/N) mTICI 0 to 1	2.1% (6/285)	1.4% (2/141)	>0.999
mTICI 2 a	1.8% (5/285)	3.5% (5/141)	0.310
mTICI 2b	25.3% (72/285)	29.8% (42/141)	0.353
mTICI 2 c	15.8% (45/285)	14.2% (20/141)	0.775
mTICI 3	55.1% (157/285)	51.1% (72/141)	0.470

mTICI, modified Thrombolysis in Cerebral Ischemia; sICH, symptomatic intracranial hemorrhage.

The current study showed no statistically significant difference in final excellent reperfusion rates between groups. A retrospective study conducted by Bageac *et al* suggested a trend towards complete reperfusion with a distal placement technique using a flexible 088 guide catheter, although this was also not statistically significant.[17] The authors postulated that distal positioning of the guide catheter might provide more support for EVT device navigation and maneuvering while decreasing the length of the path between the engaged thrombus and the evacuation point.[17]A study conducted by Milburn *et al* found significantly higher rates of final excellent reperfusion following distal catheter placement compared with proximal catheter placement.[7] Berns *et al* demonstrated flow reduction in the middle cerebral artery with higher guide catheter position leading to significantly reduced downstream migration of thrombus during thrombectomy and overall similar rates of flow control as a balloon guide catheter.[18] Possible mechanisms leading to better technical results in patients with high guide positions include stability, less potential to lose clot with shorter distance of pull, and reduced flow to the middle cerebral artery with higher guide positioning.[13] We observed similar rates of sICH between the two groups. Similarly, the incidence of new distal emboli was comparable between the two groups.

Positioning of the guide catheter in the current study was solely based on the operator preference and comfort level. Operator preference at our institution is to place guide catheters as distally as possible to maximize stability and flow control. The current study demonstrated that the Imperative Care Zoom 88 catheter was used in most cases of intracranial guide positioning. This catheter is designed for intracranial access, with specific features including increased overall support, longer length, soft atraumatic distal segment, and an atraumatic beveled tip that is more navigable.[19] The length and supportive nature of this catheter also allow for more distal placement.[19]

Our study has several limitations, including the retrospective, non-randomized nature of the analysis and absence of independent adjudication. The nature of the study design might introduce bias and affect the validity of the results. This study did not collect comorbidity information, which might influence patient outcomes using the described techniques. Furthermore, the wide range of guide catheters and aspiration catheters used, particularly among the control group, might add to the data heterogeneity. Further independent prospectively designed studies are warranted to validate our findings.

CONCLUSION

This multicenter analysis demonstrates that large bore guide catheter positioning in the petrous segment or higher during EVT for anterior circulation stroke is associated with a higher rate of FPE and shorter procedure times.

Correction notice Since this paper first published, the second and third author have switched positions in the author group. PR is now listed as the second author and MAK third.

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Contributors Conceptualization: DG, MA-K, SM. Methodology: DG, MA-K, SM, JMM, RDT, PG, VF, GV, MP. Data curation: DG, MA-K, JS, SM, PR, KAY, TH. Formal data analysis and investigation: DG, MA-K, AM. Original draft preparation: DG, PR, SM. Review and editing of the manuscript: DG, MA-K, PR, JMM, DT, SM. Project supervision: DG, MA-K, SM. DG is the overall guarantor of the study.

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Ethics approval This study involves human participants and was approved by Icahn School of Medicine at Mount Sinai Institutional Review Board (IRB) under STUDY-21-00086.Due to the retrospective nature of this study, obtaining patient consent from all patients was not feasible. After IRB review, consent was waived owing to the retrospective nature of this study.

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