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Macrowire-only direct aspiration first-pass technique for endovascular mechanical thrombectomy: Multicenter technical series using the 0.035″ aristotle Colossus wire

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Abstract

Background: Larger "macrowires" may facilitate microcatheter-free delivery of large-bore aspiration catheters (ACs) for intracranial endovascular mechanical thrombectomy. We examined the safety and efficacy of the Aristotle Colossus Guidewire for this use.

Methods: In this retrospective analysis of prospective data from 12 institutions, we identified anterior circulation endovascular mechanical thrombectomy cases involving the Aristotle Colossus guidewire over a 12-month period. The primary efficacy endpoint was successful delivery of the AC to the site without the use of adjunct devices. Multivariable logistic regression was performed with clinically relevant covariables.

Results: In 122 patients (median age 74 years (interquartile range (IQR) 63–82)), most intracranial occlusions were in the M1 segment of the middle cerebral artery (95/122, 78.0%). The primary endpoint of microcatheter-free AC delivery was met in 87.7% (107/122) of patients; 93/122 (76.2%) patients underwent microcatheter-free delivery with successful reperfusion via contact aspiration (modified thrombolysis in cerebral infarction grade $\geq$ 2B). The median number of passes was 1 (IQR 1–2). Multivariable regression demonstrated that severe internal carotid artery tortuosity or cervical loop presence (odds ratio (OR): 0.09, 95% confidence interval (CI): 0.01–0.54, $p = 0.01$) and presence of intracranial atherosclerotic disease (OR: 0.15, 95% CI: 0.03–0.83, $p = 0.03$) were significantly associated with lower odds of successful AC delivery over the guidewire. Intraprocedural vasospasm occurred in 4.9% (6/122) of cases; there were no reports of vessel dissection or perforation.

Conclusions: We demonstrate the favorable performance of the Aristotle Colossus guidewire for anterior circulation ischemic stroke intervention. The macrowire appears to safely facilitate navigation of the neurovasculature by large-bore ACs without the need for microcatheter and/or stentriever.

Keywords

Large-vessel occlusion, ischemic stroke, thrombectomy, aspiration catheter, guidewire, endovascular

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Introduction

Recent advances in aspiration catheter (AC) technology have resulted in the routine use of large-bore ACs for stroke thrombectomy procedures. Large-bore catheters have been associated with higher rates of recanalization and first-pass reperfusion as well as faster procedure times in aspiration thrombectomy.[1,2] Increases in catheter inner lumen diameter come with increased ledge effect, wherein catheters can have difficulty advancing past the ophthalmic origin or tortuous anatomy. Mitigation of this ledge effect with microwires of larger caliber has been demonstrated to facilitate more rapid and effective thrombectomy procedures.[3] The advent of soft and torqueable large-profile microwires, frequently dubbed "macrowires," has also facilitated a macrowire-only AC delivery strategy with good efficacy and the potential for cost minimization.[4] We evaluated the safety and efficacy of the Aristotle Colossus Guidewire (Scientia Vascular, West Valley City, UT), a 0.035-inch guidewire with an indication for use in the neurovasculature, for the delivery of large-bore ACs to intracranial occlusions of the anterior circulation without the need to use a microcatheter.

Methods

This retrospective study was approved by local institutional review boards with waivers of informed consent. Analysis was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[5]

We retrospectively reviewed prospectively collected acute stroke thrombectomy databases at 12 institutions to identify patients who underwent anterior circulation thrombectomy procedures using the Aristotle Colossus guidewire from April 2023 to April 2024. Cases in which aspiration-first thrombectomy was performed using the Aristotle Colossus for microcatheter-free delivery of large-bore ACs (0.068″ and larger) to the site of the anterior circulation occlusion were included.

The primary efficacy outcome was the rate of successful delivery of the AC to the target site without the use of adjunct devices (microcatheter or stentriever; i.e. adjunct-free delivery (AFD)). Secondary outcomes included the rates of combined AFD and successful reperfusion (modified thrombolysis in cerebral infarction (mTICI) grade 2B or better) via contact aspiration, successful reperfusion alone via contact aspiration, and first-pass reperfusion. Safety outcomes included intraprocedural complications such as vasospasm and vessel dissection/perforation.

Statistical analysis

Continuous variables were summarized as medians with interquartile ranges (IQRs). Categorical variables were summarized as frequencies. Univariable and multivariable logistic regression models for the primary efficacy outcome and secondary outcomes were performed with the following clinically relevant covariables: age, occlusion location, presence of extracranial/intracranial tandem occlusion, presence of intracranial atherosclerotic disease, presence of severe cervical internal carotid artery (ICA) tortuosity, balloon-guide catheter use, base catheter location, and siphon type (which was previously described by Lin et al.[6]). Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were reported for independently associated covariables. Model performance was assessed using area under the curve (AUC) from receiver operator curve analyses. The significance level was prespecified at 0.05. Statistical analyses were performed using JMP v 17.0.1 (SAS Institute Inc., Cary, NC).

Results

Demographics and anatomical considerations

In total, 122 patients at 12 institutions were identified as meeting enrollment criteria during the study time period of April 2023 to April 2024. Demographic and anatomic characteristics are described in Table 1. The median patient age was 74 years (IQR 63–82 years), and 77.9% of occlusions were at the M1 segment. Tandem occlusions, involving the cervical ICA and an intracranial vessel, were encountered in 9.8% of the population, and severe cervical ICA tortuosity was seen in 10.7% of patients. Among patients for whom siphon type was reported (n = 121), type 1 (1A and 1B) siphons were the most common, accounting for 56.2% of the population.

Procedural outcomes

Procedural characteristics are outlined in Table 2. ACs were delivered successfully to the location of occlusion without adjunctive microcatheter or stentriever support in 107 patients (87.7%), and successful reperfusion via aspiration thrombectomy was achieved in 98 patients (80.3%). Ultimately, 76.2% of patients achieved the combined secondary outcome of AFD and successful reperfusion (mTICI ≥2B) via aspiration thrombectomy. Successful reperfusion (mTICI ≥2B) was ultimately achieved in 96.7% of the cohort (118 patients). First-pass reperfusion was achieved in 76 (62.3%) cases, and the median time from access to complete reperfusion was 20 minutes.

Of procedures that did not achieve AFD (n = 15), 7 required the addition of a microcatheter for delivery and 8 required both microcatheter and stentriever to deliver the AC. In procedures with successful contact aspiration (n = 98), the median number of aspiration passes was 1.6. In procedures requiring stentriever assistance for final reperfusion (n = 24), the median number of aspiration passes was 2.6 and stentriever-assisted passes was 1.1.

Nine different large-bore ACs were used in this series, with the most commonly used ACs being Zoom71 (Imperative Care, Campbell, CA) (40.2%) and SOFIA 6F (Microvention, Aliso Viejo, CA) (35.2%) (Table 3). In catheter brands that were used in 4 or more patients,

Table 1. Demographics and occlusion characteristics of 122 patients.

Characteristic	Value
Age (years), median (IQR)	74 (63–82)
Occlusion site, no. (%)	
ICA-T	9 (7.4)
M1	95 (77.9)
M2	17 (13.9)
M3	1 (0.8)
Tandem occlusion, no. (%)	12 (9.8)
Suspected ICAD as LVO source, no. (%)	19 (15.6)
Presence of cervical loop/severe cervical ICA tortuosity, no. (%)	13 (10.7)
Siphon type, no. (%)	
1A	41 (33.9)
1B	27 (22.3)
2	27 (22.3)
3	21 (17.4)
4	5 (4.1)

ICA: internal carotid artery; ICAD: intracranial atherosclerotic disease; ICA-T: internal carotid artery terminus; IQR: interquartile range; LVO: large vessel occlusion; M1: M1 segment of the middle cerebral artery; M2: M2 segment of the middle cerebral artery; M3: M3 segment of the middle cerebral artery.

Table 2. Procedural data in 122 patients.

Variable	Value
Successful AFD of AC, no. (%)	107 (87.7)
Successful final reperfusion (mTICI 2B/2C/3) via AT, no. (%)	98 (80.3)
Successful combination AFD and reperfusion via AT, no. (%)	93 (76.2)
Successful final reperfusion (mTICI 2B/2C/3), no. (%)	118 (96.7)
First-pass reperfusion, no. (%)	76 (62.3)
Final mTICI score, no. (%)	
0	2 (1.6)
2A	2 (1.6)
2B	22 (18.0)
2C	18 (14.8)
3	78 (63.9)
Use of balloon-guided catheter, no. (%)	35 (28.7)
Location of base catheter, no. (%)	
Proximal cervical ICA	24 (19.7)
Distal cervical ICA	58 (47.5)
Petrous carotid/intracranial	40 (32.8)
Cross clot with wire, no. (%)	40 (32.8)
Time from access to reperfusion (min), median (IQR)	20 (11.5–34)
Time from first aspiration system induction to final reperfusion (minutes), median (IQR)	5 (2.0–21.5)
AFD failures	15 (12.3%)
Microcatheter required to deliver AC, no. (%)	7 (5.7)
Microcatheter and stentreiver required to deliver AC, no. (%)	8 (6.5)

AC: aspiration catheter; AFD: adjunct-free delivery; AT: aspiration thrombectomy; ICA: internal carotid artery; IQR: interquartile range; mTICI: modified treatment in cerebral infarction score.

Table 3. Aspiration catheter usage in 122 patients.

Catheter used (manufacturer)	Number of patients (%)	Successful AFD (%)	Combination AFD and successful AT (%)
Zoom71 (Imperative Care)	49 (40.2)	45 (92.0)	39 (80.0)
Zoom88 (Imperative Care)	2 (1.6)	2 (100)	2 (100)
RED72 (Penumbra)	4 (3.3)	4 (100)	4 (100)
RED68 (Penumbra)	5 (4.1)	5 (100)	4 (80.0)
Hippo 72 (Q'Apel)	2 (1.6)	0	0
Cereglide71 (Cerenovus)	8 (6.6)	7 (88.0)	6 (75.0)
APRO 70 (Medtronic)	5 (4.1)	5 (100)	4 (80.0)
SOFIA 6F (Microvention)	43 (35.2)	35 (81.0)	31 (72.0)
Esperance 6F (Wallaby Medical)	4 (3.3)	4 (100)	3 (75.0)

AFD: adjunct-free delivery; AT: aspiration thrombectomy.

the rate of successful AFD was similar among all catheters (range: 81%–100%), as was the rate of combined successful AFD and successful reperfusion via contact aspiration (range 72%–100%).

Multivariable analyses (Tables 4–6) accounting for covariables known to affect procedural efficacy identified only intracranial atherosclerotic disease (ICAD)-related occlusion and cervical ICA tortuosity/presence of cervical loop as independent predictors of failure of AFD ($p = 0.03$ and $p = 0.01$, respectively) and of failure of the combined endpoint of AFD and successful reperfusion via aspiration thrombectomy ($p < 0.001$ and $p = 0.01$, respectively). Analysis of first-pass reperfusion in this cohort identified the absence of ICAD-related occlusion ($p = 0.003$) and use of a balloon-guide catheter ($p = 0.03$) as predictors of success.

Safety outcomes

Safety outcomes are reported in Table 7. No instances of vessel dissection or perforation were noted in this series. Vasospasm was reported in six patients (4.9%). Of these, three required intra-arterial calcium channel blocker administration for treatment and three demonstrated self-resolution. Symptomatic intracerebral hemorrhage was noted in six patients.

Discussion

We report the largest multicenter experience using the Aristotle Colossus guidewire for microcatheter-free

Table 4. Univariable and multivariable logistic regressions for the outcome of successful adjunct-free delivery to occlusion.

	Univariable logistic regression		Multivariable logistic regression*	
Variable	Unadjusted odds ratio (95% CI)	p-Value	Adjusted odds ratio (95% CI)	p-Value
Age (per year)	1.01 (0.97–1.04)	0.76	0.99 (0.94–1.04)	0.68
Occlusion site				
M2/M3	Reference	–	Reference	–
M1	0.37 (0.05–3.03)	0.35	0.14 (0.01–1.83)	0.13
ICA-T	0.47 (0.03–8.52)	0.61	0.64 (0.02–18.2)	0.79
Tandem occlusion (yes vs. no)	0.37 (0.09–1.55)	0.17	0.27 (0.04–1.80)	0.18
Severe ICAD (yes vs. no)	**0.14 (0.04–0.47)**	**0.001**	**0.15 (0.03–0.83)**	**0.03**
Cervical loop/severe ICA tortuosity (yes vs. no)	**0.16 (0.04–0.59)**	**0.01**	**0.09 (0.01–0.54)**	**0.01**
Balloon-guided catheter (yes vs. no)	1.12 (0.33–3.79)	0.85	0.96 (0.18–5.24)	0.97
Base catheter location				
Petrous carotid/intracranial	Reference	–	Reference	–
Distal cervical ICA	0.38 (0.08–1.95)	0.25	0.33 (0.04–2.57)	0.29
Proximal cervical ICA	**0.16 (0.03–0.86)**	**0.03**	**0.18 (0.02–1.64)**	**0.13**
Siphon type				
1A	Reference	–	Reference	–
1B	2.14 (0.40–11.50)	0.37	1.57 (0.21–12.02)	0.66
2	0.99 (0.25–3.88)	0.98	1.62 (0.29–9.18)	0.58
3	3.43 (0.38–30.55)	0.27	9.15 (0.69–12.45)	0.09
4	0.26 (0.04–1.88)	0.18	0.83 (0.04–15.27)	0.90

*Adjusted for covariables that are known to affect intraprocedural efficacy and the ability for neurovascular devices to navigate to the target site: age, occlusion site, tandem occlusion, ICAD, cervical loop/severe cervical ICA tortuosity, balloon-guided catheter use, location of base catheter, and siphon type. Multivariable model area under the curve was 0.88 (95% CI: 0.76–0.94).
Boldface font indicates statistical significance at $p < 0.05$.
CI: confidence interval; ICA: internal carotid artery; ICAD: intracranial atherosclerotic disease; ICA-T: internal carotid artery terminus; M1: M1 segment of the middle cerebral artery; M2: M2 segment of the middle cerebral artery; M3: M3 segment of the middle cerebral artery.

Table 5. Univariable and multivariable logistic regressions for the outcome of successful adjunct-free delivery and successful reperfusion via aspiration thrombectomy.

	Univariable logistic regression		Multivariable logistic regression*	
Variable	Unadjusted odds ratio (95% CI)	p-Value	Adjusted odds ratio (95% CI)	p-Value
Age (per year)	0.99 (0.97–1.02)	0.69	0.98 (0.95–1.02)	0.39
Occlusion site				
M2/M3	Reference	–	Reference	–
M1	1.36 (0.43–4.24)	0.60	0.96 (0.24–3.84)	0.95
ICA-T	0.77 (0.14–4.33)	0.77	1.26 (0.17–9.40)	0.82
Tandem occlusion (yes vs. no)	0.59 (0.16–2.12)	0.42	0.67 (0.14–3.28)	0.62
Severe ICAD (yes vs. no)	**0.12 (0.04–0.34)**	**<0.001**	**0.07 (0.02–0.30)**	**<0.001**
Cervical loop/severe ICA tortuosity (yes vs. no)	**0.22 (0.07–0.71)**	**0.01**	**0.10 (0.02–0.47)**	**0.01**
Balloon-guided catheter (yes vs. no)	1.74 (0.64–4.72)	0.28	1.67 (0.46–6.12)	0.44
Base catheter location				
Petrous carotid/intracranial	Reference	–	Reference	–
Distal cervical ICA	1.24 (0.46–3.34)	0.67	1.43 (0.41–5.01)	0.57
Proximal cervical ICA	0.48 (0.16–1.47)	0.20	1.80 (0.36–8.95)	0.47
Siphon type				
1A	Reference	–	Reference	–
1B	2.67 (0.77–9.31)	0.12	2.31 (0.54–9.94)	0.26
2	1.33 (0.45–3.92)	0.61	1.35 (0.36–5.10)	0.66
3	2.79 (0.70–11.16)	0.15	4.19 (0.76–23.11)	0.10
4	0.70 (0.10–4.69)	0.71	3.51 (0.23–54.31)	0.37

*Adjusted for covariables that are known to affect intraprocedural efficacy and the ability of neurovascular devices: age, occlusion site, tandem occlusion, ICAD, cervical loop/severe cervical ICA tortuosity, balloon-guided catheter use, location of base catheter, and siphon type. Multivariable model area under the curve was 0.81 (95% CI: 0.70–0.89).
Bold face font indicates statistical significance at $p < 0.05$.
CI: confidence interval; ICA: internal carotid artery; ICAD: intracranial atherosclerotic disease; ICA-T: internal carotid artery terminus; M1: M1 segment of the middle cerebral artery; M2: M2 segment of the middle cerebral artery; M3: M3 segment of the middle cerebral artery.

Table 6. Univariable and multivariable logistic regressions for the outcome of successful first-pass reperfusion.

	Univariable logistic regression		Multivariable logistic regression*	
Variable	Unadjusted odds ratio (95% CI)	p-Value	Adjusted odds ratio (95% CI)	p-Value
Age (per year)	1.02 (0.99–1.04)	0.14	1.01 (0.99–1.05)	0.24
Occlusion site				
M2/M3	Reference	–	Reference	–
M1	1.44 (0.52–3.98)	0.49	0.98 (0.31–3.10)	0.97
ICA-T	1.0 (0.20–5.00)	1.00	1.52 (0.23–9.92)	0.66
Tandem occlusion (yes vs. no)	0.39 (0.12–1.32)	0.13	0.26 (0.06–1.11)	0.07
Severe ICAD (yes vs. no)	**0.22 (0.08–0.62)**	**0.004**	**0.11 (0.02–0.48)**	**0.003**
Cervical loop/severe ICA tortuosity (yes vs. no)	0.48 (0.15–1.52)	0.21	0.32 (0.08–1.25)	0.10
Balloon-guided catheter (yes vs. no)	**2.62 (1.07–6.41)**	**0.04**	**3.42 (1.10–10.63)**	**0.03**
Base catheter location				
Petrous carotid/intracranial	Reference	–	Reference	–
Distal cervical ICA	1.48 (0.64–3.44)	0.36	1.11 (0.41–3.04)	0.83
Proximal cervical ICA	0.67 (0.24–1.85)	0.44	1.71 (0.45–6.57)	0.43
Siphon type				
1A	Reference	–	Reference	–
1B	1.33 (0.49–3.60)	0.57	1.23 (0.39–3.86)	0.72
2	1.33 (0.49–3.61)	0.57	1.26 (0.40–4.02)	0.69
3	1.57 (0.52–4.69)	0.42	1.17 (0.32–4.26)	0.81
4	3.13 (0.32–30.50)	0.33	20.15 (0.97–41.37)	0.06

*Adjusted for covariables that are known to affect intraprocedural efficacy and the ability of neurovascular devices: age, occlusion site, tandem occlusion, ICAD, cervical loop/severe cervical ICA tortuosity, balloon-guided catheter use, location of base catheter, and siphon type. Multivariable model area under the curve was 0.75 (95% CI: 0.66–0.83).

Boldface font indicates statistical significance at $p < 0.05$.

CI: confidence interval; ICA : internal carotid artery; ICAD: intracranial atherosclerotic disease; ICA-T: internal carotid artery terminus; M1: M1 segment of the middle cerebral artery; M2: M2 segment of the middle cerebral artery; M3: M3 segment of the middle cerebral artery.

Table 7. Postprocedural outcomes and safety in 122 patients.

Characteristic	Value
Intraprocedural complications, no. (%)	
Dissection	0 (0)
Perforation/contrast extravasation	0 (0)
Vasospasm	6 (4.9)
Symptomatic ICH, no. (%)	6 (4.9)
Distal reocclusion/thrombus, no. (%)	26 (21.3)

ICH: intracranial hemorrhage.

delivery of large-bore ACs during anterior circulation aspiration thrombectomy procedures.

The increasing size of ACs and the resultant delivery difficulties have led to the development of various delivery technologies intended to reduce ledge effect. These technologies include the Tenzing 7 delivery catheter (Route 92 Medical, San Mateo, CA), the AXS Offset delivery assist catheter (Stryker, Fremont, CA), and the SENDit (Penumbra, Alameda, CA), the first two of which have been demonstrated to be safe and effective when delivering large-bore ACs into the intracranial circulation with low procedural complication rates and high rates of successful reperfusion.[7,8] The Aristotle Colossus guidewire functions in a similar manner to other delivery assist devices, negating ledge effect for successful and safe delivery of large-bore ACs, while offering a number of additional advantages. Foremost, because the wire has torqueability and a shapable tip, the operator can easily catheterize branch vessels, even in tortuous intracranial anatomy. Although the dominant occlusion subtype in our series was the M1 segment of the middle cerebral artery, operators also used the Aristotle Colossus guidewire for thrombectomies in the M2 and M3 segments (14.7% of our population), where specific selection of branch vessels is often required. In addition, relative to other assist devices, the lower profile of the Aristotle Colossus wire allows for use with a variety of ACs and is not bound by a small window of catheter size compatibility.

Microcatheter-free delivery using the Aristotle24 macrowire has been previously described in the literature, with our group reporting a 77.8% rate of successful AC delivery—without the need for an intervening microcatheter—and overall TICI ≥2b rate of 93.3% with no intracranial vascular complications.[4] Given the above, we believe that the larger profile of the Aristotle Colossus may facilitate better delivery of ACs because of decreased ledge effect and increased catheter support. We achieved high rates of AFD (87.7%), with excellent rates of successful reperfusion via aspiration thrombectomy (80.3%), short procedural times (20 minutes), and low rates of intraprocedural complication (Table 2). These outcome data are similar to previously published data regarding the use of delivery assist devices for AC delivery to the intracranial occlusion (88% and 96% with Offset and Tenzing, respectively).[7,8] Importantly, we report no cases of vessel

dissection (0% and 2.5% with Offset and Tenzing, respectively) and very low rates of vasospasm (4.9% in our experience, and unreported in others, with no patients requiring angioplasty and 3 patients receiving intra-arterial calcium channel blockers for treatment). These minor complications are consistent with rates of complications published in traditional ADAPT experiences.[1]

Although all ACs performed similarly in regards to AFD as well as combination AFD and successful reperfusion via aspiration thrombectomy, the presence of cervical tortuosity/cervical loops and intracranial atherosclerotic disease were independent predictors of AFD failure. Successful AFD appears to be more closely related to base catheter support and the presence of intrinsic vascular disease than it does to AC selection. Additionally, we found that there was no difference in the rate of successful AFD based on whether or not the Aristotle Colossus wire was needed to "cross" the clot (84.6% rate of AFD when crossing the clot vs. 89.8% rate of AFD when not crossing the clot, $p = 0.53$), which underscores that the properties of the guidewire afforded excellent trackability for the different large-bore ACs. In clinical practice, one might posit that not needing to position the guidewire past the occlusion could mitigate the risk of pushing the clot distally.

An interesting subset in this experience is the 12 patients (10.2%) in whom operators were able to achieve AFD but who still required stentriever for ultimate final reperfusion. This subset of patients may be amenable to stentriever-free aspiration with emerging novel pulsatile and oscillatory aspiration strategies or perhaps invite innovation regarding microcatheter-free stentriever delivery options.[9,10]

One limitation of microcatheter-free delivery with the Aristotle Colossus guidewire is the potential need for additional system components that would facilitate AC delivery and/or the use of a stentriever in the absence of successful AFD and aspiration. "Bail-out" maneuvers in this series involved either the use of a medium-bore (0.038–0.043″) intermediate catheter over the Aristotle Colossus guidewire or the discontinuation of the use of the Aristotle Colossus guidewire and replacement with a smaller microcatheter/microwire configuration that could facilitate the use of a stentriever. Although our study was not designed to demonstrate cost minimization, it stands to reason that the cost benefits of avoiding the use of adjuncts in nearly 80% of cases may constitute a cost-conscious thrombectomy solution.

Limitations

As with many retrospective experiences, this report is limited by a relatively small number of participating institutions and a relatively small sample size. Further evaluation of this technology on a larger scale is necessary to ascertain safety and effectiveness more generally. Additionally, although cost minimization may be inferred through our series, a further analysis using patient-specific data and procedural costs is necessary to claim a true cost benefit of this emerging technology.

Conclusion

We report the largest multicenter experience using the Aristotle Colossus guidewire for delivery of large-bore ACs during aspiration thrombectomy procedures for ischemic stroke. Our outcomes suggest that the technique can be safe and effective, with high rates of successful reperfusion and low rates of complications.

Abbreviations

AC	aspiration catheter
AFD	adjunct-free delivery
ICA	internal carotid artery
mTICI	modified thrombolysis in cerebral infarction

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Authors' contributions

WA and RG were involved in conception, methodology and writing—original draft; and MK in formal analysis. All the authors were involved in investigation and writing—review and editing.

Consent to participate

The requirement for informed consent to participate was waived by local institutional review boards at the participating institutions.

Data availability

De-identified data may be made available upon reasonable request to the corresponding author.

Declaration of Conflicting Interests

Dr. Ares is a consultant for Scientia Vascular. Dr. Tonetti is a consultant for Scientia Vascular. Dr. Brinjikji is a consultant for Johson & Johnson Medical Devices & Diagnostics Group – Latin America, Johnson & Johnson, Marblehead Medical, Medtronic USA, Medtronic Vascular, Microvention, MIVI Neurovascular, and Stryker. Dr. Birnbaum is a consultant for Imperative Care and Rapid AI. Dr. Chowdhry is a consultant and proctor for Medtronic and Microvention. Dr. Do serves on the board for Scientia Vascular. Dr. Malek is a consultant for CereVasc Inc. and Cerus Endovascular Ltd. Dr. Grandhi is a consultant for Balt Neurovascular, Cerenovus, Medtronic Neurovascular, Rapid Medical, and Stryker Neurovascular and received an educational grant from Scientia Neurovascular. The other authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical considerations

This retrospective study was approved by local institutional review boards at the participating institutions.

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