

SUPPLEMENTAL MATERIAL

Internal carotid artery tortuosity: impact on mechanical thrombectomy

Table I. The endovascular devices used in the present study

Table II. Baseline characteristics according to location of internal carotid artery tortuosity

Table III. Influence of extracranial and cavernous internal carotid artery tortuosity on outcomes with non-tortuous group referenced

Figure I. Influence of internal carotid artery tortuosity on first pass effect according to the occlusion site

Figure II. The distribution of modified Rankin Scale score at 3 months

Table I. The endovascular devices used in the present study

Devices	No.	Manufacturer
Stent retriever		
Solitaire, 6mm	65	Medtronic, California, USA
Solitaire, 4mm	73	Medtronic, California, USA
Trevo, 6mm	17	Stryker Neurovascular, California, USA
Trevo, 4mm	62	Stryker Neurovascular, California, USA
Trevo, 3mm	46	Stryker Neurovascular, California, USA
Embotrap II, 5mm	25	Cerenovus, California, USA
Tron, 6mm	2	Biomedical Solutions, Tokyo, Japan
Tron, 4mm	16	Biomedical Solutions, Tokyo, Japan
Tron, 2mm	7	Biomedical Solutions, Tokyo, Japan
Aspiration catheter		
JET 7	11	Penumbra, Inc., California, USA
JET D	2	Penumbra, Inc., California, USA
ACE68	44	Penumbra, Inc., California, USA
ACE60	163	Penumbra, Inc., California, USA
4MAX	46	Penumbra, Inc., California, USA
3MAX	69	Penumbra, Inc., California, USA
Sofia 6Fr	7	MicroVeniton, California, USA
Sofia 5Fr	3	MicroVeniton, California, USA
Catalyst 7	4	Stryker Neurovascular, California, USA
Catalyst 6	15	Stryker Neurovascular, California, USA
React 71	19	Medtronic, California, USA
React 68	7	Medtronic, California, USA

Table II. Baseline characteristics according to location of internal carotid artery tortuosity

	No tortuosity (n=246)	Extracranial ICA tortuosity (n=35)	Cavernous ICA tortuosity (n=70)	Tortuosity at both sites (n=19)
Age, y	77 (70–83)	83 (77–87)	78 (72–83)	82 (75–84)
Female	97 (39)	20 (57)	37 (53)	13 (68)
Body weight, kg*	57 (48–64)	54 (46–60)	54 (47–65)	53 (46–64)
Premorbid mRS score	0 (0–2)	0 (0–2)	0 (0–0)	0 (0–3)
Baseline NIHSS score*	18 (13–24)	24 (18–29)	19 (13–24)	19 (14–26)
Admission systolic BP, mmHg	152 (134–172)	145 (131–180)	151 (134–168)	156 (145–176)
ASPECTS	8 (6–10)	8 (6–9)	8 (6–10)	8 (7–10)
Medical history				
Atrial fibrillation [†]	151 (62)	31 (89)	48 (69)	17 (90)
Hypertension*	178 (73)	27 (77)	47 (67)	16 (84)
Diabetes mellitus [‡]	51 (21)	4 (11)	17 (25)	6 (32)
Dyslipidemia*	110 (45)	14 (40)	35 (50)	9 (47)
Ischemic heart disease*	38 (16)	5 (14)	8 (11)	3 (16)
Previous stroke/TIA*	54 (22)	6 (17)	12 (17)	6 (32)
Current smoking [§]	36 (15)	4 (12)	8 (11)	1 (5)
Initial site of occlusion				
Extracranial ICA	19 (8)	4 (11)	6 (9)	0 (0)
Intracranial ICA	59 (24)	15 (43)	13 (19)	12 (63)
Proximal M1	44 (18)	3 (9)	17 (24)	1 (5)

Distal M1	66 (27)	7 (20)	17 (24)	2 (11)
M2	58 (24)	6 (17)	17 (24)	4 (21)
First-line MT strategy				
SR	81 (33)	9 (26)	23 (33)	7 (37)
CA	92 (37)	10 (29)	25 (36)	5 (26)
Combined SR and CA	60 (24)	14 (40)	16 (23)	6 (32)
Manual aspiration through the guide catheter	2 (1)	0 (0)	2 (3)	0 (0)
Attempt only	11 (5)	2 (6)	4 (6)	1 (5)
Onset to hospital arrival time, min	108 (49–326)	82 (51–285)	63 (41–238)	54 (39–253)
Onset to puncture time, min	190 (115–419)	163 (109–342)	167 (108–298)	129 (93–335)
Intravenous thrombolysis	107 (44)	13 (37)	37 (53)	12 (63)

Data are presented as medians (interquartile range) or n (%).

*1 missing value (1 in the non-tortuous group).

†2 missing values (2 in the non-tortuous group).

‡3 missing values (2 in the non-tortuous group and 1 in the cavernous ICA tortuosity group).

§2 missing values (1 in the non-tortuous group and 1 in the extracranial ICA tortuosity group).

Abbreviations: ICA, internal carotid artery; mRS, modified Rankin Scale; NIHSS, National Institute of Health Stroke Scale; BP, blood pressure; ASPECTS, Alberta Stroke Program Early Computed Tomographic Score; TIA, transient ischemic attack; M1, first segment of the middle cerebral artery; M2, second segment of the middle cerebral artery; MT, mechanical thrombectomy; SR, stent retriever; CA, contact aspiration.

Table III. Influence of extracranial and cavernous internal carotid artery tortuosity on outcomes with non-tortuous group referenced

	Extracranial ICA tortuosity (n=35)	Cavernous ICA tortuosity (n=70)	Extracranial ICA tortuosity vs. No tortuosity Adjusted OR* (95%CI)	Cavernous ICA tortuosity vs. No tortuosity Adjusted OR† (95%CI)
Procedural outcomes‡				
First pass effect	6 (18)	17 (26)	0.37 (0.14–0.96)	0.63 (0.34–1.19)
Modified first pass effect	9 (27)	34 (52)	0.31 (0.13–0.72)	1.01 (0.57–1.78)
Final eTICI 2c/3	18 (51)	29 (41)	0.80 (0.38–1.70)	0.54 (0.31–0.94)
Final eTICI 2b/3	30 (86)	61 (87)	1.23 (0.43–3.56)	1.36 (0.61–3.03)
Procedural complications	2 (6)	4 (6)	0.93 (0.17–5.16)	0.95 (0.28–3.18)
Clinical outcomes‡				
Favorable outcome	14 (40)	36 (51)	1.25 (0.49–3.17)	1.10 (0.57–2.10)
Excellent outcome	9 (26)	21 (30)	1.16 (0.42–3.20)	0.75 (0.38–1.45)
Poor outcome	10 (29)	8 (11)	1.25 (0.48–3.26)	0.79 (0.32–1.92)
Neurological improvement at 7 days	20 (57)	35 (51)	0.67 (0.31–1.47)	0.55 (0.31–0.98)
Safety outcomes§				
Any ICH	18 (51)	39 (56)	1.47 (0.70–3.09)	1.68 (0.97–2.92)
SAH	8 (23)	20 (29)	1.52 (0.62–3.76)	1.96 (1.03–3.71)
Parenchymal hematoma	2 (6)	8 (11)	1.27 (0.25–6.42)	2.65 (0.98–7.21)
Symptomatic ICH	0 (0)	5 (7)	–	3.35 (0.84–13.39)

Data are presented as n (%).

*ORs with 95% CIs for the extracranial ICA tortuous group were calculated using the non-tortuous group as reference.

†ORs with 95% CIs for the cavernous ICA tortuous group were calculated using the non-tortuous group as reference.

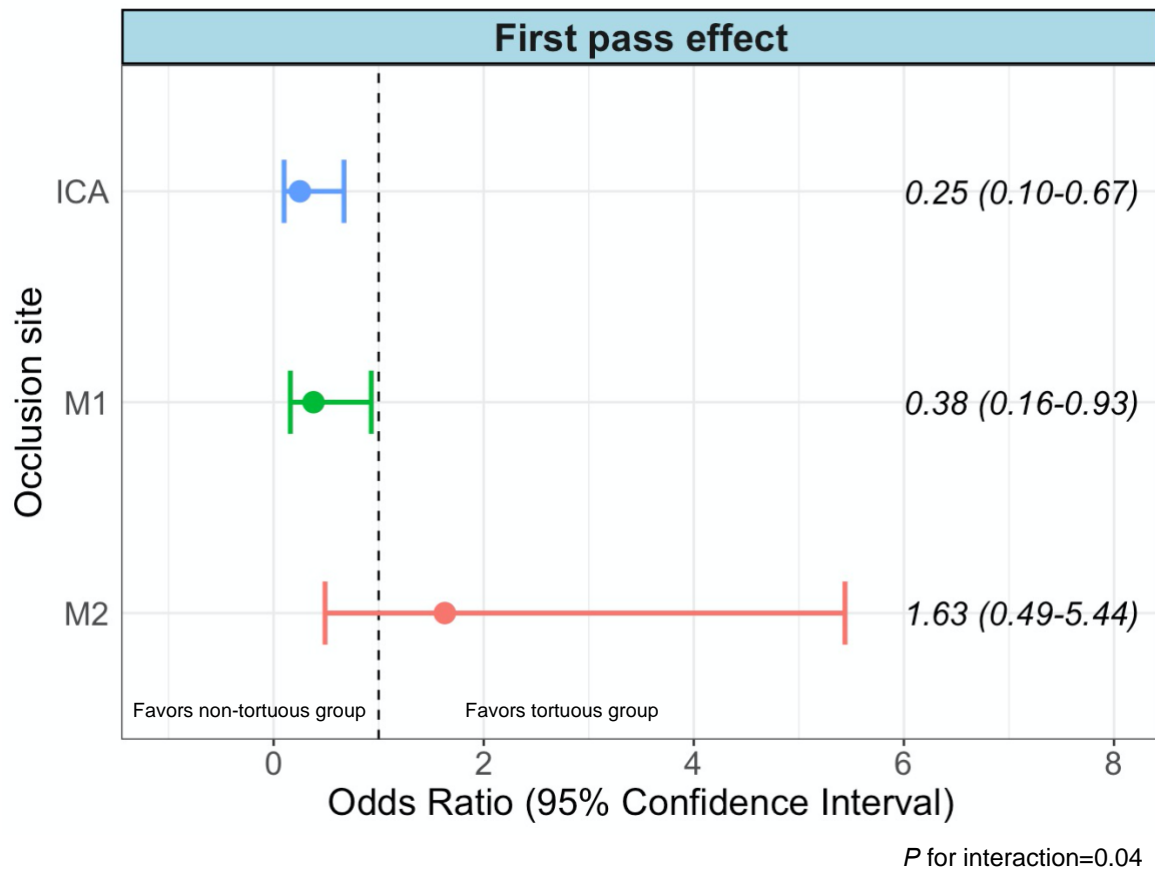
‡Models for procedural and clinical outcomes adjust for age, sex, body weight, premorbid mRS score, baseline NIHSS score, occlusion site, first-line MT strategy, and onset to puncture time.

§Models for safety outcomes adjust for age, sex, body weight, baseline NIHSS score, occlusion site, intravenous thrombolysis, first-line MT strategy, and onset to puncture time.

||First pass effect and modified first pass effect were assessed in 33 patients of the tortuous group and 66 patients of the non-tortuous group.

Abbreviations: ICA, internal carotid artery; OR, odds ratio; CI, confidence interval; eTICI, extended Thrombolysis In Cerebral Infarction; ICH, intracranial hemorrhage; SAH, subarachnoid hemorrhage; mRS, modified Rankin Scale; NIHSS, National Institute of Health Stroke Scale; MT, mechanical thrombectomy.

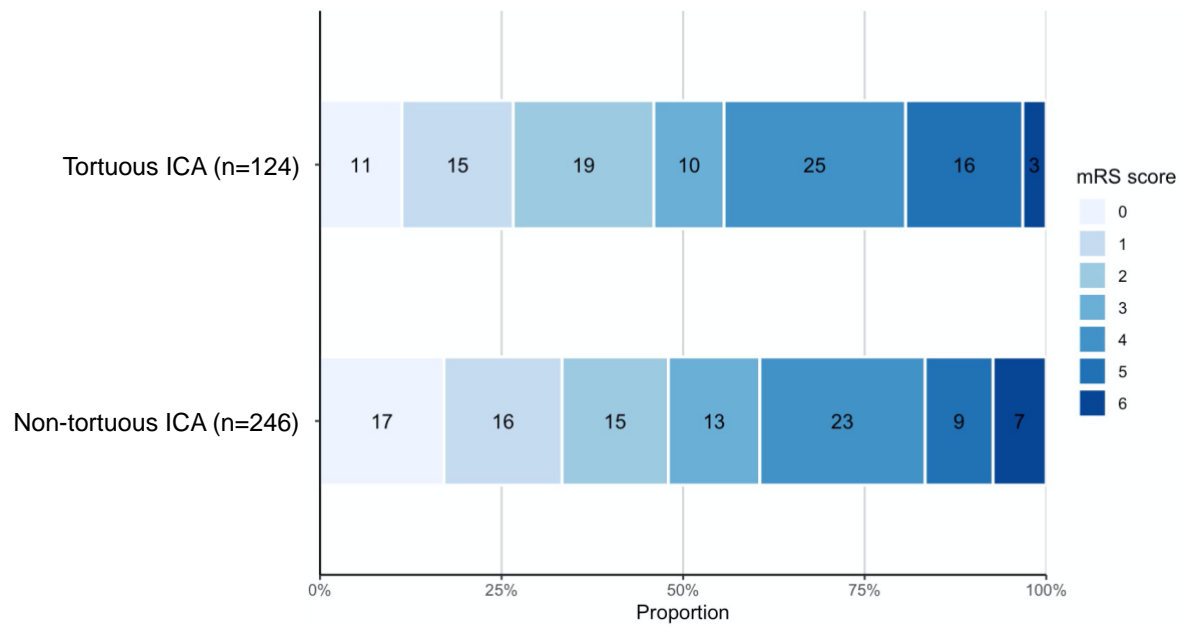
Figure I. Influence of internal carotid artery tortuosity on first pass effect according to the occlusion site



Forest plot summarizes the odds ratio obtained for comparison of the tortuous and non-tortuous groups on first pass effect according to each occlusion site.

Abbreviations: ICA, internal carotid artery; M1, first segment of the middle cerebral artery; M2, second segment of the middle cerebral artery.

Figure II. The distribution of modified Rankin Scale score at 3 months



Abbreviations: mRS, modified Rankin Scale.