Supplementary Information

S1. Supplementary Figures

S1.1. Correlation between local geometric parameters

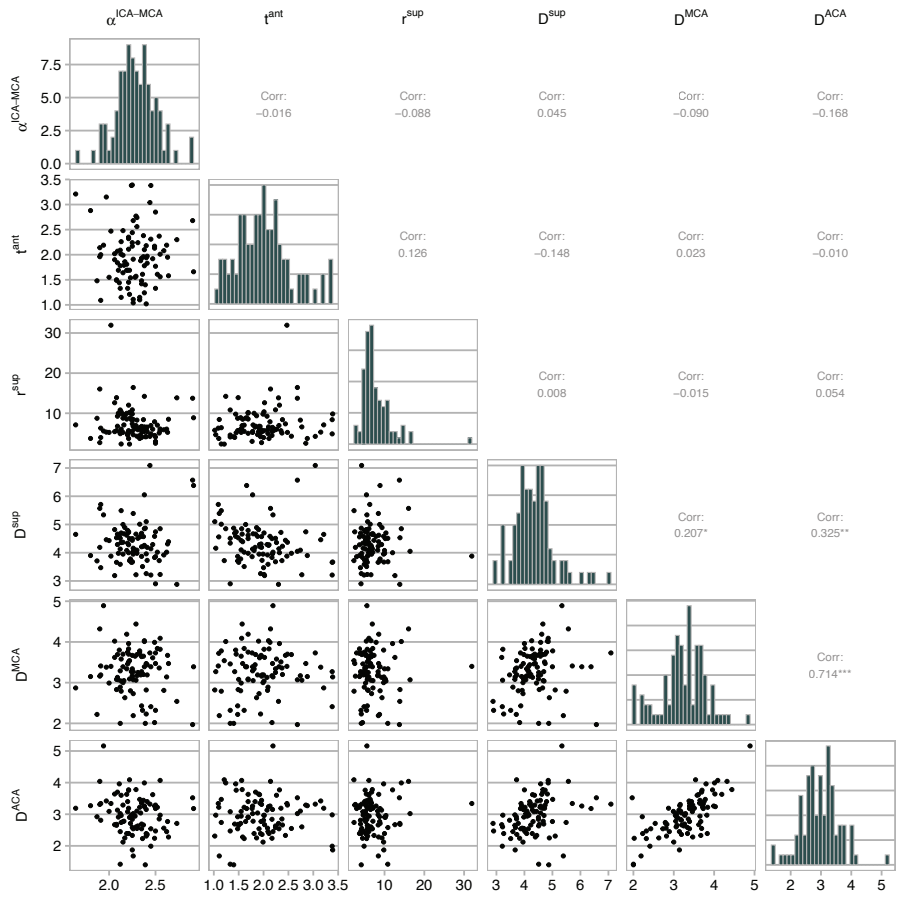
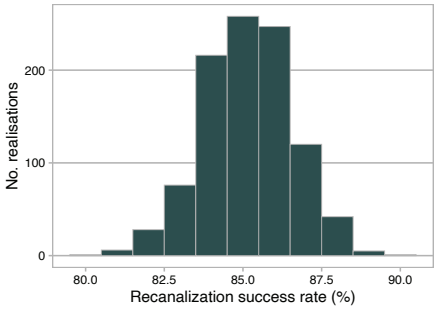
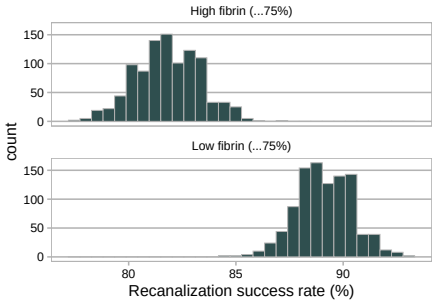


Figure S1: Correlation between the local geometric parameters. We determined the correlation between the different local geometric characteristics that were determined to be signification predictors of thrombectomy outcome. The only correlations that were determined to be significant were those between the three diameter parameters: diameter of MCA (D^{MCA}), ACA (D^{ACA}), and the ICA superior bend (D^{sup}).The remaining parameters in the figure are: the angle between the ICA and MCA ($\alpha^{ICA-MCA}$); tortuosity of the anterior bend (t^{ant}); and curvature of the ICA superior bend (r^{sup}).

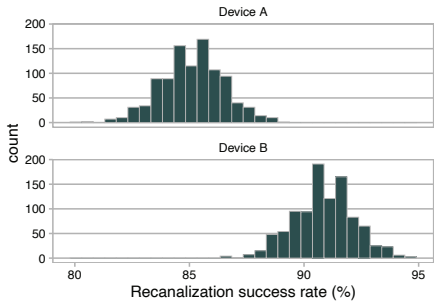
S1.2. In silico trial distributions



(a) *In silico* MR CLEAN Trial



(b) Thrombus Composition Trial



(c) Device Comparison Trial

Figure S2: Distribution of recanalization success for the ISTs executed in this study. These distributions are obtained from 1000 realisations for each patient in the trial.

S2. Supplementary Tables

S2.1. Vascular anatomy parameters

In Section 2.1 (main manuscript) the list of 28 anatomy parameters calculated for each patient-specific vascular model is presented, and in [1] the method for the calculation of the parameters is extensively explained. In Table S1 we report the median and interquartile ranges (IQR) of the parameters based on the analyzed 100 patient-specific vascular geometries.

Parameter	**Median (IQR)**
Length of the ICA bends:	
$L^{sup}[mm]$	11.77 (6.98)
$L^{ant}[mm]$	14.95 (6.54)
$L^{pos}[mm]$	11.31 (4.47)
$L^{inf}[mm]$	7.25 (3.96)
Average diameter of the ICA bends:	
$D^{sup}[mm]$	4.29 (0.78)
$D^{ant}[mm]$	5.12 (1.14)
$D^{pos}[mm]$	5.21 (1.63)
$D^{inf}[mm]$	4.43 (1.32)
Radius of curvature of the ICA bends:	
$r^{sup}[mm]$	6.21 (3.60)
$r^{ant}[mm]$	3.29 (1.32)
$r^{pos}[mm]$	4.13 (2.64)
$r^{inf}[mm]$	8.15 (7.14)
Tortuosity of the ICA bends:	
$t^{sup}[-]$	0.12 (0.15)
$t^{ant}[-]$	0.94 (0.67)
$t^{pos}[-]$	0.19 (0.34)
$t^{inf}[-]$	0.02 (0.04)
Angles between adjacent ICA bends:	
$\alpha^{sup-ant}[°]$	91.78 (35.80)
$\alpha^{ant-pos}[°]$	131.89 (29.93)
$\alpha^{pos-inf}[°]$	131.10 (48.12)
Distance between the bifurcation point and the starting point of the superior bend	
$d^{T-sup}[mm]$	2.95 (2.82)
Distances between adjacent bends:	
$d^{sup-ant}[mm]$	6.24 (2.53)
$d^{ant-pos}[mm]$	5.44 (2.69)
$d^{pos-inf}[mm]$	3.33 (2.88)
Angles at the T-junction (bifurcation of the ICA into MCA and ACA):	
$\alpha^{ICA-ACA}[°]$	65.48 (12.30)
$\alpha^{ICA-MCA}[°]$	129.46 (15.41)
$\alpha^{MCA-ACA}[°]$	140.85 (15.96)
Average MCA and ACA diameters:	
$D^{MCA}[mm]$	3.34 (0.64)
$D^{ACA}[mm]$	2.95 (0.74)

Table S1: Vascular anatomy parameters: median and interquartile range (IQR) calculated on the 100 patient-patient specific vascular anatomies used for training the thrombectomy surrogate model.

S2.2. Comparison of patients with local geometrical characteristics with the complete MR CLEAN Registry population

Here we provide a the clinical, pre-treatment and workflow characteristics of the complete MR CLEAN Registry population and compare these charac-

teristics between patients with and without local geometrical measurements.

Characteristic	Complete population (n = 3279)	Excluded (n = 3179)	Included (n = 100)	p-value
Clinical				
Age (yr)	72(61-80)	72(61-80)	73(62-81)	1.00
Male sex—no./%	1696/51%	1646/52%	50/50%	0.8
Systolic Blood Pressure (mmHg)	150(131-165)	150(132-165)	151(131-163)	0.73
NIH Stroke Scale	16(11-20)	16(11-20)	14(10-18)	0.03
Pre-treatment mRS	0(0-1)	0(0-1)	0(0-1)	0.12
Previous stroke—no./%	546/17%	534/17%	12/12%	0.26
Diabetes mellitus—no./%	532/16%	513/16%	19/19%	0.55
Atrial fibrillation —no./%	772/24%	751/24%	21/21%	0.61
Workflow				
Onset to ER (mins)	57(39-105)	57(39-105)	55(41-103)	0.81
ER to EVT (mins)	119(87-154)	119(87-154)	113(90-150)	0.67
Baseline imaging				
Collateral score	2(1-2)	2(1-2)	2(1-2)	0.02
ASPECTS	9(7-10)	9(7-10)	9(8-10)	0.13

Table S2: Comparison between the patients with local geometrical parameters and the patients of MR CLEAN Registry

S3. Supplementary Methods

S3.1. Finite-element thrombectomy simulations

Simulations were performed using mesh geometries extracted from AIS patient geometries. Segmentations of cerebral vessels from 100 stroke patients were collected from the MR CLEAN Registry [2], and vessel centerlines

and diameters were extracted. Three-dimensional reconstructions of the vessels most commonly affected by acute ischemic stroke: the internal carotid artery (ICA), the middle cerebral artery (MCA) and the anterior cerebral artery (ACA), were obtained with the software SolidWorks (Dassault Systèmes, France). The vascular models were discretized with quadrilateral rigid elements of 0.2 mm average element size.

In each vascular geometry model, a thrombus was placed in the M1 segment of the MCA, the most frequent occlusion location [3]. The thrombus diameter was set to occlude 90% of the M1 lumen. The length and composition (percentage of fibrin/platelets content) of the thrombi were not available for the patients. Consequently, for each geometry, two FE simulations were run with different thrombus characteristics (one red blood cells-rich and one fibrin/platelets-rich) which were sampled from population distributions in the MR CLEAN Registry (Fig. S3).

The thrombi were discretized with linear tetrahedral elements (0.2 mm average element size) and modeled with a quasi-hyperelastic foam material available in the finite-elements (FE) solver LS-DYNA (ANSYS, USA). The material parameters were calibrated with unconfined compression tests conducted on *ex vivo* thrombi directly after the retrieval [4]. The compression tests were performed on different thrombus compositions, from red blood cells-rich to fibrin/platelets-rich, and the material curve was interpolated for untested thrombus compositions using linear regression.

Two sent-retriever models were created, which we denote Device A and

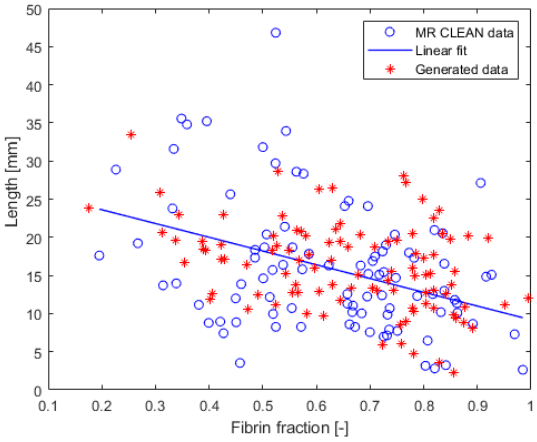


Figure S3: Thrombus length and fibrin fraction from patients in the MR CLEAN Registry (blue dots with indicated linear fitting) and generated for the 100 computational simulations (red stars).

Device B. In one case the stent geometry was reconstructed by observing the real device, while for the other the CAD model was already available. Both stent models were discretized with Hughes-Liu beam elements of 0.2 mm average element size. The nickel-titanium material was modeled with the shape memory alloy material formulation available in LS-DYNA, and the material parameters were calibrated with uniaxial tensile tests on the real devices [5]. A micro-catheter of 0.8 mm diameter was also modeled and discretized with quadrilateral rigid elements (0.2 mm average element size).

The simulation reproduces a clinical thrombectomy procedure performed with stent-retriever, without aspiration catheters, and with blood flow arrest (using a balloon guide catheter). Moreover, an optimal stent positioning is assumed with respect to the occlusion location, i.e. with two thirds of the stent length beyond the thrombus terminus, following clinical guidelines [6].

The steps of the simulation are (see Fig. 2 in Section 2.1):

1. catheter positioning and stent crimping: the micro-catheter is positioned inside the vessel and pushes the thrombus against the vessel wall; in the meantime, the stent-retriever is crimped inside an auxiliary catheter;
2. stent tracking: the crimped stent moves inside the micro-catheter and reaches the occlusion;
3. stent deployment: the micro-catheter unsheathing is simulated by rigidly moving the catheter, so that the stent is released, expands and entraps the thrombus;
4. retrieval: the stent-thrombus complex is retrieved along the micro-catheter centerline.

Further information about the simulation settings can be found in Luraghi et al.[5]. The models were prepared with ANSA (BETA CAE Systems, Switzerland) and the simulations were run with LS-DYNA on 28 CPUs of an Intel Xeon64 with 250 GB of RAM and lasted 29–50 hours. The simulation outputs were post-processed and recanalization success of the procedure was determined. Successful recanalization was defined as removal of the thrombus from the vessel.

S4. Acknowledgements

S4.1. INSIST investigators

Charles Majoie[1], Ed van Bavel[2], Henk Marquering[1,2], Nerea Arrarte-Terreros[1,2], Praneeta Konduri[1,2], Sissy Georgakopoulou[2], Yvo Roos[3], Alfons Hoekstra[4], Raymond Padmos[4], Claire Miller[4], Victor Azizi[4], Aad van der Lugt[5], Diederik W.J. Dippel[6], Hester L. Lingsma[7], Nikki Boodt[5,6,7], Noor Samuels[5,6,7], Stephen Payne[8], Tamas Jozsa[8], Wahbi K. El-Bouri[8], Michael Gilvarry[9], Ray McCarthy[9], Sharon Duffy[9], Behrooz Fereidoonnezhad[10], Kevin Moerman[10], Patrick Mc Garry[10], Senna Staessens[11], Simon de Meyer[11], Francesco Migliavacca[12], Gabriele Dubini[12], Giulia Luraghi[12], Sara Bridio[12], Jose Felix Rodriguez Matas[12], Bastien Chopard[13], Franck Raynaud[13], Remy Petkantchin[13], Vanessa Blanc-Guillemaud[14], Mikhail Panteleev[15,16], Alexey Shibeko[15], Karim Zouaoui Boudjeltia[17]

Affliations: Department of Radiology and Nuclear Medicine[1], Biomedical Engineering and Physics[2], Neurology[3], Amsterdam UMC, location University of Amsterdam, Amsterdam, the Netherlands; Computational Science Lab, Faculty of Science, Institute for Informatics, University of Amsterdam, Amsterdam, the Netherlands[4], Department of Radiology and Nuclear Medicine[5], Neurology[6], Public Health[7], Erasmus MC University Medical Center, PO Box 2040, 3000 CA Rotterdam, the Netherlands; Institute of Biomedical Engineering, Department of Engineering Science, University of Oxford, Parks Road, Oxford OX1 3PJ, UK[8]; Cerenovus, Galway Neuro Technology Centre, Galway, Ireland[9]; College of Engineering and Informatics, National University of Ireland Galway, Ireland; National Centre for Biomedical Engi-

neering Science, National University of Ireland Galway, Ireland[10]; Laboratory for Thrombosis Research, KU Leuven Campus Kulak Kortrijk, Kortrijk, Belgium[11]; Laboratory of Biological Structure Mechanics, Department of Chemistry, Materials and Chemical Engineering 'Giulio Natta', Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milano, Italy[12]; Computer Science Department, University of Geneva, CUI, 7 route de Drize, 1227 Carouge, Switzerland[13]; Institut de Recherches Internationales Servier, Coubevoie Cedex, France[14]; Center for Theoretical Problems of Physicochemical Pharmacology RAS, Moscow, Russia[15]; Dmitry Rogachev National Research Center of Pediatric Hematology, Oncology and Immunology, Moscow, Russia; Faculty of Physics, Lomonosov Moscow State University, Moscow, Russia[16]; Laboratory of Experimental Medicine (ULB 222 Unit), Université Libre de Bruxelles (ULB), CHU de Charleroi, Belgium[17]

S4.2. MR CLEAN Registry investigators

Executive committee: Diederik W.J. Dippel[1]; Aad van der Lugt[2]; Charles B.L.M. Majoie[3]; YvoB.W.E.M. Roos[4]; Robert J. van Oostenbrugge[5]; Wim H. van Zwam[6]6; Jelis Boiten[14]; Jan Albert Vos[8]

Study coordinators: Ivo G.H. Jansen[3]; Maxim J.H.L. Mulder[1,2]; Robert-Jan B. Goldhoorn[5,6]; Kars C.J. Compagne[2]; Manon Kappelhof[3]; Josje Brouwer[4]; Sanne J. den Hartog[1,2,40]; Wouter H. Hinsenveld [5,6];

Local principal investigators: Diederik W.J. Dippel[1]; Bob Roozenbeek[1]; Aad van der Lugt[2]; Adriaan C.G.M. van Es[2];Charles B.L.M. Majoie[3]; Yvo

B.W.E.M. Roos[4]; Bart J. Emmer[3];Jonathan M. Coutinho[4]; Wouter J. Schonewille[7]; Jan Albert Vos[8]; Marieke J.H.Wermer[9]; Marianne A.A. van Walderveen[10]; Julie Staals[5]; Robert J. van Oostenbrugge[5]; Wim H.van Zwam[6]; Jeannette Hofmeijer[11]; Jasper M. Martens[12]; Geert J.Lycklama à Nijeholt[13]; Jelis Boiten[14]; Sebastiaan F. de Bruijn[15]; Lukas C. van Dijk[16]; H. Bart van der Worp[17]; Rob H.Lo[18]; Ewoud J. van Dijk[19]; Hieronymus D. Boogaarts[20]; J. de Vries[22]; Paul L.M. de Kort[21]; Juliavan Tuijl[21]; Jo P. Peluso[26]; Puck Fransen[22];Jan S.P. van den Berg[22]; Boudewijn A.A.M. van Hasselt[23]; Leo A.M. Aerden[24]; René J. Dallinga[25]; Maarten Uyttenboogaart[28]; Omid Eschgi[29]; Reinoud P.H. Bokkers[29]; Tobien H.C.M.L. Schreuder[30]; Roel J.J. Heijboer[31]; Koos Keizer[32]; Lonneke S.F. Yo[33]; Heleen M. den Hertog[22]; Tomas Bulut[35]; Paul J.A.M. Brouwers[34]

Imaging assessment committee: Charles B.L.M. Majoie[3](chair); Wim H. van Zwam[6]; Aad van der Lugt[2]; Geert J. Lycklama à Nijeholt[13]; Marianne A.A. van Walderveen[10]; Marieke E.S. Sprengers[3]; Sjoerd F.M. Jenniskens[27]; René van den Berg[3]; Albert J. Yoo[38]; Ludo F.M. Beenen[3]; Alida A. Postma[6]; Stefan D. Roosendaal[3]; Bas F.W. van der Kallen[13]; Ido R. van den Wijngaard[13]; Adriaan C.G.M. van Es[2]; Bart J. Emmer[3]; Jasper M. Martens[12]; Lonneke S.F. Yo[33]; Jan Albert Vos[8]; Joost Bot[36], Pieter-Jan van Doormaal[2]; Anton Meijer[27];Elyas Ghariq[13]; Reinoud P.H. Bokkers[29];Marc P. van Proosdij[37]; G. Menno Krietemeijer[33]; Jo P. Peluso[26];Hieronymus D. Boogaarts[20]; Rob Lo[18]; Dick Gerrits[35]; Wouter Dinkelaar[2], Auke P.A. Appelman[29]; Bas Hammer[16]; Sjoert Pegge[27]; Anouk van der Hoorn[29]; Saman Vinke[20].

Writing committee: Diederik W.J. Dippel[1](chair); Aad van der Lugt[2]; Charles B.L.M.Majoie[3]; Yvo B.W.E.M. Roos[4]; Robert J. van Oostenbrugge[5]; Wim H. van Zwam[6]; Geert J. Lycklama à Nijeholt1[3]; Jelis Boiten[14]; Jan Albert Vos[8]; Wouter J. Schonewille[7]; Jeannette Hofmeijer[11]; Jasper M. Martens[12]; H. Bart van der Worp[17]; Rob H. Lo[18]

Adverse event committee: Robert J. van Oostenbrugge[5](chair); Jeannette Hofmeijer[11]; H. Zwenneke Flach[23]

Trial methodologist: Hester F. Lingsma[40]

Research nurses / local trial coordinators: Naziha el Ghannouti[1]; Martin Sterrenberg[1]; Wilma Pellikaan[1]; Rita Sprengers[4]; Marjan Elfrink[11]; Michellec Simons[11]; Marjolein Vossers[12]; Joke de Meris[14]; Tamara Vermeulen[14]; Annet Geerlings[1]9; Gina van Vemde[22]; Tiny Simons[30]; Gert Messchendorp[28]; Nynke Nicolaij[28]; Hester Bongenaar[32]; Karin Bodde[24]; Sandra Kleijn[34]; Jasmijn Lodico[34]; Hanneke Droste[34]; Maureen Wollaert[5]; Sabrina Verheesen[5]; D. Jeurrissen[5]; Erna Bos[9]; Yvonne Drabbe[15]; Michelle Sandiman[15]; Nicoline Aaldering[11]; Berber Zweedijk[17]; Jocova Vervoort[21]; Eva Ponjee[22]; Sharon Romviel[19]; Karin Kanselaar[19]; Denn Barning[10].

PhD / Medical students: Esmee Venema[40]; Vicky Chalos1,[40]; Ralph R. Geuskens[3]; Tim van Straaten[19]; Saliha Ergezen[1]; Roger R.M. Harmsma[1]; Daan Muijres[1]; Anouk de Jong[1]; Olvert A. Berkhemer[1,3,6]; Anna M.M. Boers[3,39]; J. Huguet[3];P.F.C. Groot[3]; Marieke A. Mens[3]; Katinka R. van Kranendonk[3]; Kilian M. Treurniet[3]; Manon L. Tolhuisen[3,39]; Heitor Alves[3]; Annick J. Weterings[3], Eleonora L.F. Kirkels[3], Eva J.H.F. Voogd[11]; Lieve M.

Schupp[3]; Sabine L. Collette[28,29]; Adrien E.D. Groot[4]; Natalie E. LeCouffe[4]; Praneeta R. Konduri[39]; Haryadi Prasetya[39]; Nerea Arrarte-Terreros[39]; Lucas A. Ramos[39].

Affiliations: Department of Neurology[1], Radiology[2], Public Health[40], Erasmus MC University Medical Center; Department of Radiology and Nuclear Medicine[3], Neurology[4], Biomedical Engineering and Physics[39], Amsterdam UMC, University of Amsterdam, Amsterdam; Department of Neurology[5], Radiology[6], Maastricht University Medical Center and Cardiovascular Research Institute Maastricht (CARIM); Department of Neurology[7], Radiology[8], Sint Antonius Hospital, Nieuwegein; Department of Neurology[9], Radiology[10], Leiden University Medical Center; Department of Neurology[11], Radiology[12], Rijnstate Hospital, Arnhem; Department of Radiology[13], Neurology[14], Haaglanden MC, the Hague; Department of Neurology[15], Radiology[16], HAGA Hospital, the Hague; Department of Neurology[17], Radiology[18], University Medical Center Utrecht; Department of Neurology[19], Neurosurgery[20], Radiology[27], Radboud University Medical Center, Nijmegen; Department of Neurology[21], Radiology[26], Elisabeth-TweeSteden ziekenhuis, Tilburg; Department of Neurology[22], Radiology[23], Isala Klinieken, Zwolle; Department of Neurology[24], Radiology[25], Reinier de Graaf Gasthuis, Delft; Department of Neurology[28], Radiology[29], University Medical Center Groningen; Department of Neurology[30], Radiology[31], Atrium Medical Center, Heerlen; Department of Neurology[32], Radiology[33], Catharina Hospital, Eindhoven; Department of Neurology[34], Radiology[35], Medical Spectrum Twente, Enschede; Department of Radiology[36], Amster-

dam UMC, Vrije Universiteit van Amsterdam, Amsterdam; Department of Radiology[37], Noordwest Ziekenhuisgroep, Alkmaar; Department of Radiology[38], Texas Stroke Institute, Texas, United States of America

S4.3. MR CLEAN trial investigators

Olvert A. Berkhemer, Amsterdam UMC, location AMC, the Netherlands and Erasmus MC-University Medical Center Rotterdam, the Netherlands. Puck S.S. Fransen, Erasmus MC-University Medical Center Rotterdam, the Netherlands. Debbie Beumer, Erasmus MC-University Medical Center Rotterdam, the Netherlands and Maastricht University Medical Center and Cardiovascular Research Institute Maas-tricht (CARIM), the Netherlands. Berkhemer, Fransen, and Beumer contributed equally. Lucie A. van den Berg, Amsterdam UMC, location AMC, the Netherlands. Hester F. Lingsma, Erasmus MC-University Medical Center Rotterdam, the Netherlands. Albert J. Yoo, Massachusetts General Hospital, Boston, United States of America. Wouter J. Schonewille, Saint Antonius Hospital, Nieuwegein, the Netherlands. Jan Albert Vos, MD, Sint Antonius Hospital, Nieuwegein, the Netherlands. Paul J. Nederkoorn, Amsterdam UMC, location AMC, the Netherlands. Marieke J.H. Wermer and Marianne A.A. van Walderveen, Leiden University Medical Center, the Netherlands. Julie Staals, Maastricht University Medical Center and Cardiovascular Research Institute Maastricht (CARIM), the Nether-lands. Jeannette Hofmeijer and Jacques A. van Oostayen, Rijnstate Hospital, Arnhem, the Netherlands. Geert J. Lycklama à

Nijeholt and Jelis Boiten, MC Haaglanden, the Hague, the Netherlands. Patrick A. Brouwer and Bart J. Emmer, Erasmus MC-University Medical Center Rotterdam, the Netherlands. Sebastiaan F. de Bruijn and Lukas C. van Dijk, HAGA Hospital, the Hague, the Netherlands. L. Jaap Kappelle, University Medical Center Utrecht, the Netherlands. Rob H. Lo, University Medical Center Utrecht, the Netherlands. Ewoud J. van Dijk and Joost de Vries, Radboud University Medical Center, Nijmegen, the Netherlands. Paul L.M. de Kort and Willem Jan J. van Rooij, Sint Elisabeth Hospital, Tilburg, the Netherlands. Jan S.P. van den Berg and Boudewijn A.A.M. van Hasselt, Isala Klinieken, Zwolle, the Netherlands. Leo A.M. Aerden and René J. Dallinga, Reinier de Graaf Gasthuis, Delft, the Netherlands. Marieke C. Visser and Joseph C.J. Bot, Amsterdam UMC, location VU, Amsterdam, the Netherlands. Patrick C. Vroomen and Omid Eshghi, University Medical Center Groningen, the Nether-lands. Tobien H.C.M.L. Schreuder and Roel J.J. Heijboer, Atrium Medical Center, Heerlen, the Ne-therlands. Koos Keizer and Alexander V. Tielbeek, Catharina Hospital, Eindhoven, the Netherlands. Heleen M. den Hertog and Dick G. Gerrits, Medical Spectrum Twente, Enschede, the Netherlands. Renske M. van den Berg-Vos and Giorgos B. Karas, Sint Lucas Andreas Hospital, Amsterdam, the Netherlands. Ewout W. Steyerberg, Erasmus MC-University Medical Center Rotterdam, the Nether-lands. H. Zwenneke Flach, Isala Klinieken, Zwolle, the Netherlands. Henk A. Marquering and Marieke E.S. Sprengers, Amsterdam UMC, location AMC, the Netherlands. Sjoerd F.M. Jenniskens, Radboud Univer-

sity Medical Center, Nijmegen, the Netherlands. Ludo F.M. Beenen and René van den Berg, Amsterdam UMC, location AMC, the Netherlands. Peter J. Koudstaal and Wim H. van Zwam, Eras-mus MC-University Medical Center Rotterdam, the Netherlands. Yvo B.W.E.M. Roos, Amsterdam UMC, location AMC, the Netherlands. Aad van der Lugt, Erasmus MC-University Medical Center Rotterdam, the Netherlands. Robert J. van Oostenbrugge, Maastricht University Medical Center and Cardiovascular Research Institute Maastricht (CARIM), the Netherlands. Charles B.L.M. Majoie, Am-sterdam UMC, location AMC, the Netherlands. Diederik W.J. Dippel, Erasmus MC-University Medi-cal Center Rotterdam, the Netherlands. van Zwam, Roos, van der Lugt, van Oostenbrugge, Majoie and Dippel contributed equally.

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[1] S. Bridio, G. Luraghi, J. F. Rodriguez Matas, G. Dubini, G. G. Giassi, G. Maggio, J. N. Kawamoto, K. M. Moerman, P. McGarry, P. R. Konduri, et al., Impact of the internal carotid artery morphology on in silico stent-retriever thrombectomy outcome, Frontiers in Medical Technology (2021) 40.

[2] O. A. Berkhemer, P. S. Fransen, D. Beumer, L. A. van den Berg, H. F. Lingsma, A. J. Yoo, W. J. Schonewille, J. A. Vos, P. J. Nederkoorn, M. J. Wermer, M. A. van Walderveen, J. Staals, J. Hofmeijer, J. A. van Oostayen, G. J. Lycklama à Nijeholt, J. Boiten, P. A. Brouwer, B. J. Emmer, S. F. de Bruijn, L. C. van Dijk, L. J. Kappelle, R. H. Lo, E. J.

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