General anesthesia versus conscious sedation in mechanical thrombectomy

Katharina Feil, Moriz Herzberg, Franziska Dorn, Steffen Tiedt, Clemens Küpper, Dennis C. Thunstedt, Ludwig Christian Hinske, Konstanze Mühlbauer, Sebastian Goss, Thomas Liebig, Marianne Dieterich, Andreas Bayer, Lars Kellert

Angaben zur Veröffentlichung / Publication details:

Feil, Katharina, Moriz Herzberg, Franziska Dorn, Steffen Tiedt, Clemens Küpper, Dennis C. Thunstedt, Ludwig Christian Hinske, et al. 2021. "General anesthesia versus conscious sedation in mechanical thrombectomy." *Journal of Stroke* 23 (1): 103–12. https://doi.org/10.5853/jos.2020.02404.

JoS JOURNAL OF STROKE

Journal of Stroke 2021;23(1):103-112
https://doi.org/10.5853/jos.2020.02404

Original Article

General Anesthesia versus Conscious Sedation in Mechanical Thrombectomy

Katharina Feil,[a,b] Moriz Herzberg,[c,d] Franziska Dorn,[c] Steffen Tiedt,[e] Clemens Küpper,[a] Dennis C. Thunstedt,[a] Ludwig C. Hinske,[f,g] Konstanze Mühlbauer,[f] Sebastian Goss,[f] Thomas Liebig,[c] Marianne Dieterich,[a,h,i] Andreas Bayer,[f] Lars Kellert,[a] on Behalf of the GSR Investigators

[a]Department of Neurology, Ludwig Maximilian University (LMU), Munich, Germany
[b]Department of Neurology & Stroke, Eberhard-Karls University of Tübingen, Tübingen, Germany
[c]Institute of Neuroradiology, Ludwig Maximilian University (LMU), Munich, Germany
[d]Department of Radiology, University Hospital Würzburg, Würzburg, Germany
[e]Institute for Stroke and Dementia Research, Ludwig Maximilian University (LMU), Munich, Germany
[f]Department of Anesthesiology, Ludwig Maximilian University (LMU), Munich, Germany
[g]The Institute for Medical Information Biometry and Epidemiology (IBE), Ludwig Maximilian University (LMU), Munich, Germany
[h]Munich Cluster for Systems Neurology (SyNergy), Munich, Germany
[i]German Center for Vertigo and Balance Disorders, Ludwig Maximilian University (LMU), Munich, Germany

Background and Purpose Anesthesia regimen in patients undergoing mechanical thrombectomy (MT) is still an unresolved issue.

Methods We compared the effect of anesthesia regimen using data from the German Stroke Registry-Endovascular Treatment (GSR-ET) between June 2015 and December 2019. Degree of disability was rated by the modified Rankin Scale (mRS), and good outcome was defined as mRS 0–2. Successful reperfusion was assumed when the modified thrombolysis in cerebral infarction scale was 2b–3.

Results Out of 6,635 patients, 67.1% (n=4,453) patients underwent general anesthesia (GA), 24.9% (n=1,650) conscious sedation (CS), and 3.3% (n=219) conversion from CS to GA. Rate of successful reperfusion was similar across all three groups (83.0% vs. 84.2% vs. 82.6%, *P*=0.149). Compared to the CA-group, the GA-group had a delay from admission to groin (71.0 minutes vs. 61.0 minutes, *P*<0.001), but a comparable interval from groin to flow restoration (41.0 minutes vs. 39.0 minutes). The CS-group had the lowest rate of periprocedural complications (15.0% vs. 21.0% vs. 28.3%, *P*<0.001). The CS-group was more likely to have a good outcome at follow-up (42.1% vs. 34.2% vs. 33.5%, *P*<0.001) and a lower mortality rate (23.4% vs. 34.2% vs. 26.0%, *P*<0.001). In multivariable analysis, GA was associated with reduced achievement of good functional outcome (odds ratio [OR], 0.82; 95% confidence interval [CI], 0.71 to 0.94; *P*=0.004) and increased mortality (OR, 1.42; 95% CI, 1.23 to 1.64; *P*<0.001). Subgroup analysis for anterior circulation strokes (n=5,808) showed comparable results.

Conclusions We provide further evidence that CS during MT has advantages over GA in terms of complications, time intervals, and functional outcome.

Keywords Conscious sedation; Stroke; Reperfusion; Thrombectomy; Anesthesia; Thrombolytic therapy

Correspondence: Lars Kellert
Department of Neurology, Ludwig Maximilian University (LMU) Munich, Marchioninistrasse 15, 81377 Munich, Germany
Tel: +49-89-4400-73692
Fax: +49-89-4400-76671
E-mail: Lars.Kellert@med.uni-muenchen.de
https://orcid.org/0000-0002-4967-8336

Co-correspondence: Katharina Feil
Department of Neurology & Stroke, Eberhard-Karls University of Tübingen, Hoppe-Seyler-Strasse 6, 72076 Tübingen, Germany
Tel: +49-7071-29-61753
Fax: +49-7071-29-25297
E-mail: Katharina.feil@uni-tuebingen.de
https://orcid.org/0000-0002-4566-712X

Received: June 18, 2020
Revised: September 21, 2020
Accepted: September 22, 2020

Introduction

While mechanical thrombectomy (MT) is the standard of care in eligible patients with large vessel occlusion (LVO), the appropriate anesthesia regimen is still an unresolved issue. The primary goal of sedation management during MT is to enable the interventionalist to perform the procedure as quickly and safely as possible. However, studies on this topic have shown conflicting results. A recent meta-analysis from three randomized single-center trials showed an advantage for general anesthesia (GA) compared to conscious sedation (CS) in patients with anterior circulation strokes who underwent MT with respect to 3-month outcome.[1] Contrary to this, a *post hoc* analysis from 797 patients from the Highly Effective Reperfusion Using Multiple Endovascular Devices (HERMES) Collaboration showed that patients treated without GA had a better 3-month outcome compared to those treated under GA.[2] Data from another registry on anesthesia regimens with 4,429 patients showed,[3] that GA was associated with worse functional outcome, especially when compared with local anesthesia. Due to the lack of evidence from large clinical trials on this topic, these results have to be interpreted with caution. The supposed advantages of GA would be the patients' immobilization during MT, proper pain management, airway protection and therefore fewer periprocedural complications. The more optimal periprocedural conditions are said to lead to higher rates of successful reperfusion resulting in better functional outcome.[1] On the other hand, GA may cause a delay before groin puncture and result in complications related to intensive care management leading to an overall delay in the hospital stay. Advantages of CS include clinical and neurological monitoring, fewer hemodynamic fluctuations, and potentially shorter procedures. However, unprotected airways and patient movement are believed to have a negative influence on functional outcome. Here we aimed to analyze the real-life practice of anesthesia regimen in MT-patients from the German Stroke Registry-Endovascular Treatment (GSR-ET) and its impact on complications and outcome.[4]

Methods

Data from the GSR-ET (https://www.clinicaltrials.gov; NCT03356392) were analyzed. Details of the registry have been published previously.[4,5] See Appendix 1 for steering committee members of GSR (GSR investigators).

Study population

Between June 2015 and December 2019, 6,635 patients from 25 sites in Germany with acute ischemic stroke due to LVO, who were treated with MT, were included. The decision for MT was based on the interdisciplinary decision of treating physicians including clinical and imaging parameters and according to national (German Neurological Society) and international guidelines (European Stroke Organization, American Heart Association).[6-8]

Stroke severity was assessed by the National Institutes of Health Stroke Scale (NIHSS). Pre- and post-stroke disability was rated by the modified Rankin Scale (mRS). Early infarct signs were assessed by the Alberta Stroke Program Early CT Score (ASPECTS). Site of occlusion was determined by computed tomography angiography, magnetic resonance angiography, or angiography. Reperfusion success was measured by the modified thrombolysis in cerebral infarction (mTICI) scale and mTICI 2b-3 was rated as successful reperfusion.

The periprocedural anesthesia regimen was based on individual and interdisciplinary decisions and in-house protocols. In general, patients received either GA or CS; a small group converted from CS to GA for various periprocedural reasons. In 313 patients, the anesthesia regimen was not documented.

Statistical analysis

Continuous variables were tested for normal distribution using the Kolmogorov-Smirnov test. Normally distributed data were presented as mean±standard deviation and non-normally distributed data as median (interquartile range) or counts and percentages. Clinical characteristics, imaging data, periprocedural times, and outcome parameters were compared across the three groups using the Kruskal-Wallis test or median-test, as appropriate. Binary logistic regression analysis was performed for good outcome (mRS 0–2) and mortality at follow-up, including variables that were either statistically or clinically (or biologically) significant. For logistic regression analysis, categorical variables were defined as follows: sex male=0, female=1; intravenous thrombolysis treatment no=0, yes=1; successful recanalization no=0, yes=1; type of anesthesia CS=0, GA=1; intracerebral hemorrhage (ICH) no=0, yes=1; tandem lesion no=0, yes=1; posterior circulation stroke no=0, yes =1; pretreatment with oral anticoagulants no=0, yes=1. Converted patients and patients with unknown anesthesia regimen were excluded from the logistic analysis. For all statistical testing, we used the SPSS version 25.0 for Windows (IBM Co., Armonk, NY, USA).

Ethics

The study was conducted in accordance with the Declaration of Helsinki and was centrally approved by the Institutional Review Board (IRB) of the Ludwig-Maximilians-Universität Munich (protocol No. 689-15). Further approval was obtained

https://doi.org/10.5853//jos.2020.02404

Table 1. Characteristics of GSR-patients comparing the anesthesia regimen (n=6,635 patients, unknown in n=313)

Characteristic	Conscious sedation (n=1,650, 24.9%)	General anesthesia (n=4,453, 67.1%)	Conversion (n=219, 3.3%)	*P*
Age (yr)	73.4±13.0	73.1±13.1	70.3±13.3	0.340
Female sex	835 (50.6)	2,265 (50.9)	98 (44.7)	0.206
Clinical characteristics at admission				
pmRS	0 (0–1) (missing in n=45)	0 (0–1) (missing in n=342)	0 (0–1) (missing in n=15)	0.004
pmRS ≤ 1	1,278 (77.5)	3,237 (72.7)	167 (76.3)	0.017
Baseline NIHSS	13 (8–11)	15 (10–19)	15 (9–18)	<0.001
Drip and ship	800 (48.5)	1,834 (41.2)	108 (49.3)	<0.001
BP systolic at admission	154.7±27.4	151.0±27.4	155.5±28.0	<0.001
BP diastolic at admission	84.4±17.0	82.0±17.0	86.0±16.0	<0.001
Heart rate at admission	82.4±19.1	81.5±19.2	84.5±18.5	0.015
OAC at admission	332 (20.1)	896 (20.1)	35 (16.0)	0.116
Risk factors				
Arterial hypertension	1,229 (74.5)	3,265 (73.3)	157 (71.7)	<0.001
Diabetes mellitus	342 (20.7)	934 (21.0)	46 (21.0)	0.119
Hypercholesterolemia	532 (32.2)	1,753 (39.4)	77 (35.2)	<0.001
Current smoking	208 (12.6)	585 (13.1)	40 (18.3)	<0.001
Atrial fibrillation	662 (40.1)	1,765 (39.6)	82 (37.4)	0.348
Imaging data				
ASPECTS	9 (7–10)	9 (7–10)	8 (7–10)	0.010
Tandem lesion	221 (13.4)	730 (16.4)	39 (17.8)	0.011
Anterior circulation	1,572 (95.3)	3,786 (85.0)	194 (88.6)	<0.001
Right-sided occlusion	810 (48.7)	1,824 (40.9)	90 (41.1)	0.002
Type of occlusion*				
Basilar artery	50 (3.0)	556 (12.5)	17 (7.8)	<0.001
Vertebral artery	6 (0.4)	121 (2.7)	3 (1.4)	<0.001
PCA	30 (1.8)	147 (3.3)	8 (3.7)	0.003
ACA	35 (2.1)	108 (2.4)	3 (1.4)	0.521
Carotid-T	250 (15.2)	766 (17.2)	39 (17.8)	0.184
ICA intracranial	85 (5.2)	227 (5.1)	17 (7.8)	0.213
ICA extracranial	132 (8.0)	295 (6.6)	16 (7.3)	0.144
MCA, proximal M1	529 (32.1)	1,346 (30.2)	72 (32.9)	0.219
MCA, distal M1	394 (23.9)	778 (17.5)	40 (18.3)	<0.001
MCA, M2	361 (21.9)	959 (21.5)	45 (20.5)	0.422
Time intervals (min)				
Admission to groin	61.0 (40.0–89.0)	71.0 (47.0–103.0)	61.0 (41.0–83.0)	<0.001
Groin to flow restoration	39.0 (25.0–63.0)	41.0 (26.0–65.0)	64.5 (42.0–100.0)	<0.001
Admission to flow restoration	107.0 (76.0–143.0)	118.5 (88.0–160.0)	129.0 (97.8–179.0)	<0.001
Treatment				
IVT treatment	846 (51.3)	2,208 (49.6)	129 (58.9)	0.018
Additive medication during thrombectomy	327 (19.8)	1,548 (34.8)	54 (24.7)	<0.001
ASA	18 (1.1)	92 (2.1)	5 (2.3)	0.036
Clopidogrel	2 (0.1)	14 (0.3)	1 (0.5)	0.373
Ticagrelor	0 (0)	21 (0.5)	1 (0.5)	0.020

Table 1. Continued

Characteristic	Conscious sedation (n=1,650, 24.9%)	General anesthesia (n=4,453, 67.1%)	Conversion (n=219, 3.3%)	*P*
Tirofiban	21 (1.3)	136 (3.1)	9 (4.1)	<0.001
Abciximab	0 (0)	3 (0.1)	1 (0.5)	0.040
Heparin	226 (13.7)	1,067 (24.0)	33 (1.4)	<0.001
rtPA	47 (2.8)	93 (2.1)	6 (2.7)	0.194
Acute treatment ipsilateral ICA (stenting and/or PTA)	169 (10.2)	526 (11.8)	25 (11.4)	0.110
No. of passages	2.0±1.6	2.2±1.8	2.5±1.9	<0.001
Periprocedural complications	248 (15.0)	934 (21.0)	62 (28.3)	<0.001
Device malfunction	9 (0.5)	21 (0.5)	2 (0.9)	0.995
Dissection, perforation	42 (2.5)	130 (2.9)	14 (6.4)	0.007
Clot migration, embolization	55 (3.3)	185 (4.2)	9 (4.1)	0.426
ICH	29 (1.7)	127 (2.8)	13 (5.9)	<0.001
Vasospasm	57 (3.5)	389 (8.7)	22 (10.0)	<0.001
Resuscitation	8 (0.5)	13 (0.3)	2 (0.9)	0.070
Other	110 (6.7)	272 (6.1)	23 (10.5)	0.003
Successful reperfusion mTICI 2b/3	1,370 (83.0)	3,751 (84.2)	181 (82.6)	0.149
24-hr follow-up				
mRS	4 (3–5) (missing in n=93)	5 (3–5) (missing in n=491)	5 (4–5) (missing in n=32)	0.170
NIHSS	8 (3–16)	11 (4–20)	13 (5–23)	<0.001
Complications	705 (42.7)	2,076 (46.6)	117 (53.5)	0.002
Malignant MCA infarction	69 (4.2)	284 (6.4)	15 (6.8)	0.001
Recurrent stroke	62(3.8)	264 (5.9)	6 (2.7)	<0.001
ICH	187 (11.3)	625 (14.0)	47 (21.5)	<0.001
Myocardial infarction	30 (1.8)	75 (1.7)	2 (0.9)	0.612
Groin hematoma	34 (2.1)	64 (1.4)	7 (3.2)	0.406
Groin aneurysm	14 (0.8)	30 (0.7)	1 (0.5)	0.693
Other complications	426 (25.8)	1,278 (28.7)	72 (32.9)	0.023
Hospital stay (day)	9.5±7.5	11.3±9.5	11.1±8.1	<0.001
Discharge				
NIHSS	4 (1–11)	5 (2–12)	6 (2–13)	0.022
mRS	3 (2–5) (missing in n=17)	4 (2–5) (missing in n=325)	4 (2–5) (missing in n=9)	<0.001
Mortality (mRS 6)	188 (11.4)	775 (17.4)	27 (12.3)	<0.001

Values are presented as mean±standard deviation, number (%), or median (interquartile range).
GSR, German Stroke Registry; pmRS, pre-stroke modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; BP, blood pressure; OAC, oral anticoagulation; ASPECTS, Alberta Stroke Program Early CT Score; PCA, posterior cerebral artery; ACA, anterior cerebral artery; ICA, internal carotid artery; MCA, middle cerebral artery; IVT, intravenous thrombolysis; ASA, acetylsalicylic acid; rtPA, recombinant tissue plasminogen activator; PTA, percutaneous transluminal angioplasty; ICH, intracerebral hemorrhage; mTICI, modified thrombolysis in cerebral infarction; mRS, modified Rankin Scale.
*Multiple occlusion sites possible.

from local IRBs according to local regulations. Informed consent was not mandatory in accordance with the IRB approval since there were no study-specific procedures performed and data analysis of all patients undergoing MT was demanded by the governmental quality surveillance system.

Results

Out of 6,635 patients from the GSR-ET, 67.1% (n=4,453) underwent GA and 24.9% (n=1,650) CS during MT. In 3.3% of all patients (n=219), the anesthesia regimen was converted from

https://doi.org/10.5853//jos.2020.02404

Table 2. Logistic regression for periprocedural complications during mechanical thrombectomy in general anesthesia- and conscious sedation-groups

Variable	OR	95% CI	*P*
Age	0.99	0.98–0.99	0.002
Sex	1.09	0.93–1.27	0.291
pmRS	1.11	1.03–1.18	0.004
NIHSS at admission	0.99	0.98–1.01	0.533
Treatment with IVT	1.02	0.86–1.21	0.840
General anesthesia	1.58	1.35–1.86	<0.001
Tandem lesion	1.21	0.98–1.50	0.080
Posterior circulation stroke	0.57	0.13–2.59	0.470
Time from admission to groin puncture	1.00	0.99–1.00	0.153
ASPECTS	1.01	0.96–1.05	0.787
No. of passages	1.18	1.14–1.23	<0.001
Pretreatment (OAC)	0.78	0.62–0.97	0.025

OR, odds ratio; CI, confidence interval; pmRS, pre-stroke modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; IVT, intravenous thrombolysis; ASPECTS, Alberta Stroke Program Early CT Score; OAC, oral anticoagulation.

initial CS to GA, while the anesthesia regimen was not documented in 313 patients (4.7%). The CS- and GA-groups were of similar age and sex, but patients from the GA-group had higher pre-stroke modified Rankin Scale (pmRS) and higher NIHSS on admission (Table 1). CS-patients were more often admitted via drip and ship (48.5% vs. 41.2% vs. 49.3%, *P*<0.001). Further, the CS-group had more often patients with right-sided (48.7% vs. 40.9% vs. 41.1%, *P*=0.002) and anterior circulation stroke (95.3% vs. 85.0% vs. 88.6%, *P*<0.001). The rate of successful reperfusion was similar in all three groups (83.0% vs. 84.2% vs. 82.6%, *P*=0.149). While tandem lesions were more frequent in the GA-group (13.4% vs. 16.4% vs. 17.8%, *P*=0.011), rate of acute treatment of ipsilateral internal carotid artery (stenting and/or percutaneous transluminal angioplasty) was comparable in all groups (10.2% vs. 11.8% vs. 11.4%, *P*=0.110). GA compared to CS was associated with a significant delay from admission to groin (61.0 minutes vs. 71.0 minutes vs. 61.0 minutes, *P*<0.001). Time from groin to flow restoration did not differ between the GA- and the CS-groups (39.0 minutes vs. 41.0 minutes), while the converted group had a significantly longer time interval from groin to flow restoration (64.5 minutes, *P*<0.001). Overall, the CS-group showed the lowest rate of periprocedural complications (15.0% vs. 21.0% vs. 28.3%, *P*<0.001).

GA was independently associated with higher periprocedural complications (odds ratio [OR], 1.58; 95% confidence interval [CI], 1.35 to 1.86; *P*<0.001) (Table 2). In the GA-group, patients were more likely to receive intensive antithrombotic medications (Table 1). In the CS-group, rates of periprocedural ICH (1.7% vs. 2.8% vs. 5.9%, *P*<0.001) and complications during the whole hospital stay (42.7% vs. 46.6% vs. 53.5%, *P*=0.002) were lowest. Hospital stay was significantly shorter in the CS-group compared to GA-group and the converted group (9.5±7.5 days vs. 11.3±9.5 days vs. 11.1±8.1 days, *P*<0.001).

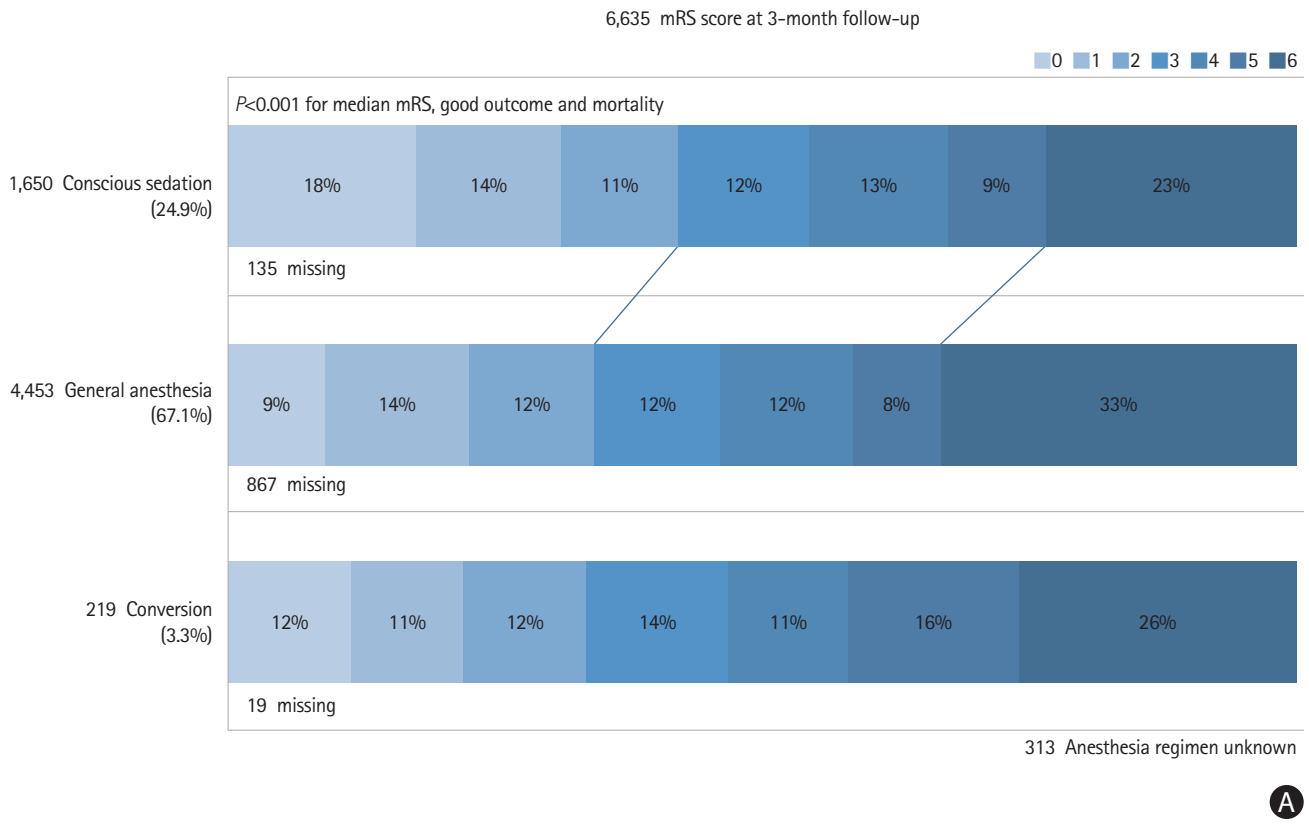
At 24 hours, CS patients performed better with respect to NIHSS (8 vs. 11 vs. 13, *P*<0.001). Three-month follow up was not available in 15.4% (n=1,021). The patients in the CS-group were more likely to achieve good outcome (42.1% vs. 34.2% vs. 33.5%, *P*<0.001) and had a lower rate of mortality (23.4% vs. 32.4% vs. 26.0%, *P*<0.001) (Figure 1A).

In multivariable analysis, GA was associated with reduced achievement of good functional outcome (OR, 0.82; 95% CI, 0.71 to 0.94; *P*=0.004) and increased mortality (OR, 1.42; 95% CI, 1.23 to 1.64; *P*<0.001) (Tables 3 and 4).

We performed an additional analysis, restricted to patients with anterior circulation strokes (n=5,808) (Supplementary Table 1), which showed comparable results with respect to time delay, complications, and outcome parameters (Figure 1B and Supplementary Tables 2 and 3).

Discussion

Here we present by far the largest sample size on anesthesia regimens in 6,635 MT-patients with the following results: GA was the most common strategy in centers within the GSR-ET; more than two-thirds of the patients received MT under GA. The GA-rate is considerably higher than reported in data from clinical trials or registry data with about 30% of patients receiving GA (28.0% to 37.6%).[9-12] In about 12% of patients starting MT under CS, a conversion to GA was necessary (cor-



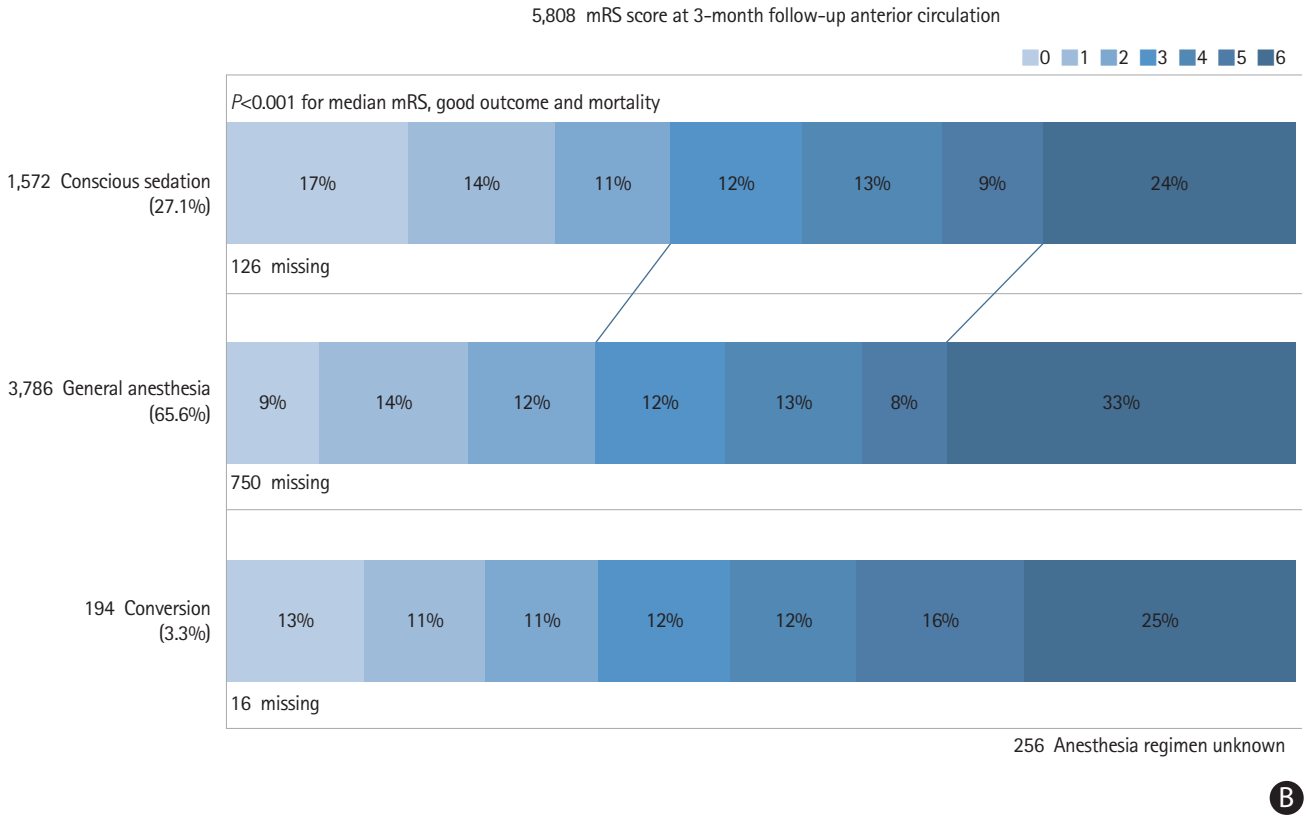


Figure 1. Modified Rankin Scale (mRS) at 3-months follow-up for all large vessel occlusion stroke (A) and for anterior circulation stroke (B). Good outcome mRS ≤2.

https://doi.org/10.5853//jos.2020.02404

Table 3. Logistic regression for good outcome in general anesthesia- and conscious sedation-groups at follow-up

Variable	OR	95% CI	*P*
Age	0.95	0.95–0.96	<0.001
Sex	1.01	0.87–1.17	0.885
pmRS	0.53	0.49–0.58	<0.001
NIHSS at admission	0.89	0.88–0.90	<0.001
Treatment with IVT	1.73	1.50–2.00	<0.001
Successful reperfusion (mTICI 2b/3)	4.87	3.82–6.22	<0.001
General anesthesia	0.82	0.71–0.94	0.004
ICH	0.26	0.21–0.33	<0.001
Time from admission to groin	0.99	0.999–1.00	0.019

OR, odds ratio; CI, confidence interval; pmRS, pre-stroke modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; IVT, intravenous thrombolysis; mTICI, modified thrombolysis in cerebral infarction; ICH, intracerebral hemorrhage.

Table 4. Logistic regression for mortality in general anesthesia- and conscious sedation-groups at follow-up

Variable	OR	95% CI	*P*
Age	1.06	1.05–1.07	<0.001
Sex	0.90	0.78–1.05	0.167
pmRS	1.35	1.27–1.42	<0.001
NIHSS at admission	1.09	1.07–1.10	<0.001
Treatment with IVT	0.64	0.56–0.74	<0.001
Successful reperfusion (mTICI 2b/3)	0.28	0.24–0.34	<0.001
General anesthesia	1.42	1.23–1.64	<0.001
ICH	2.71	2.26–3.25	<0.001
Time from admission to groin	1.00	1.00–1.00	0.114

OR, odds ratio; CI, confidence interval; pmRS, pre-stroke modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; IVT, intravenous thrombolysis; mTICI, modified thrombolysis in cerebral infarction; ICH, intracerebral hemorrhage.

responding to 3% of the whole cohort). This is in line with rates that ranged from about 10% to 15% in other studies.[13-17] In our study, patients from the CS-group performed better with respect to clinical outcomes at 24 hours, at discharge, and at follow-up after 3 months than patients with MT under GA.

Time intervals showed delayed start of groin puncture in GA-patients and therefore longer time intervals from admission to flow restoration. Successful reperfusion rate was similar across all three patient groups. More periprocedural and in-hospital complications were observed under GA—independently of possible confounders, such as tandem lesions, posterior circulation stroke, or number of passages. The interpretation of this result remains speculative. Possibly, there are confounders we cannot address appropriately yet, such as changes in blood pressure caused by GA or imbalances in baseline parameters. Thus the regression analysis cannot appropriately adjust for all these confounders. Well-balanced groups in clinical trials would be necessary to overcome these shortcomings.

Overall, these findings are in contrast to prior studies, but in line with data from another registry analyzing 4,429 patients.[3] A recent meta-analysis from three clinical trials showed an advantage of GA with respect to outcome, an effect that was most probably driven by higher rates of successful reperfusion in the GA-group.[1] Investigators speculated that GA leads to more optimal interventional conditions, resulting in higher reperfusion rates.[1] A *post hoc* analysis from 797 patients from the HERMES collaboration showed non-GA patients to have a higher rate of good outcome at 3 months compared to GA-patients.[2] However, in this *post hoc* analysis only 30% of patients were treated under GA. Besides, they used data from RCTs, which were much more homogenous with respect to pmRS, baseline parameters, and occlusion side than in our study.[2] Poorer outcome in the GA-group was most probably not only caused by periprocedural complications but could partly be explained by the fact that the GA- and CS-groups were not fully balanced. With respect to periprocedural complications, we observed higher rates of dissection and perforation, ICH, and vasospasm in the GA-group and the converted group. These

complications could have been clinical reason for conversion from CS to GA.

A recent analysis from a prospective Italian registry (Italian Registry of Endovascular Treatment of Acute Stroke [IRETAS]) showed that two-thirds of these patients were treated with CS or local anesthesia. In contrast, in centers from the GSR-ET two thirds of patients underwent MT under GA. Our patients had a pmRS of 0–1 in about 80% compared to up to 90% in IRETAS. ASPECTS in the GSR was 8–9 and 10 in IRETAS. This might partially explain the observation of different sedation regimens. However, due to different sedation regimens and different study populations the comparability of both studies is limited. Besides, our data provide further evidence for anesthesia and sedation management, especially regarding periprocedural complications that have been less well explored using a large dataset.

Our data show significantly lower systolic and diastolic blood pressure and heart rate at admission in the GA-group. However, we have no data on the temporal changes of blood pressure data, especially a significant drop which potentially increases infarct size, leading to poor outcome.[18] In the GA-group, the cumulative dose of norepinephrine—reflecting the drop in blood pressure under GA—was an independent predictor of an unfavorable outcome.[19] On the other hand, vasospasm occurred most frequently under GA. As high PaO_2 is discussed to cause intracerebral vasospasm, this effect might be more likely to occur under GA than under CS.[20] However, our data do not allow any conclusion on causality to be drawn. Thus, the causality between GA and higher occurrence of vasospasm as a periprocedural complication is speculative. In converted patients, we neither provided information on the time of the periprocedural complication nor of the conversion from GA to CS. Therefore, we cannot conclude that the periprocedural complication rate is lower in the GA-group.

With regard to the total complication rate during the hospital stay, there were clear differences with a disadvantage of GA, especially regarding the occurrence of ICH and all other complications. In the GA-group, antithrombotic medication was used more intensively. In terms of complications, rates of ICH were highest in patients treated under GA. In summary, patients under GA performed worse in every aspect.

We observed no influence of anesthesia regimen on successful reperfusion rates. The number of passages was highest in the converted group and lowest in the CS-group. However, in the GA-group, periprocedural time to groin puncture was extended by an average of 10 minutes and the delay was not compensated by the MT procedure time. Retrospective studies have suggested that the time delay through intubation may lead to worse outcome.[21] While patients undergoing MT under CS had slightly lower NIHSS at admission (13 vs. 15 in median), the difference in clinical stroke severity continued and even increased with respect to NIHSS and mRS after 24 hours, at discharge, and at 3-month follow-up. Regression analysis showed that CS was independently associated with higher probability of good outcome and lower odds for mortality at 3 months adjusted to confounders like baseline NIHSS. Patients who converted from CS to GA also had better outcome than patients in the GA- group. Besides poorer clinical outcome, GA was associated with a longer hospital stay of 2 days.

The strengths of our study include the large study cohort prospectively collected from a nationwide multicenter registry. Our data therefore represent clinical decisions on sedation management and anesthesia regimen in daily life practice, outside clinical trials. We observed the same results for the whole cohort of LVO patients as well as for anterior circulation strokes. We were able to analyze detailed information on complications and clinical follow-up. Given that it is unlikely that evidence will be established from large clinical trials in the near future, our results provide further evidence based on observational data that patients benefit from CS compared to GA.

However, our study has some limitations. Our data are observational, non-randomized and non-controlled. Therefore, interpretation of the data is prone to bias. Underlying selection bias for decision for an anesthesia regimen have to be discussed as well, even if individual variables in the patient baseline data did not differ. Individual clinical parameters, such as pmRS, NIHSS at admission or presence of tandem lesions, could have contributed to the decision for anesthesia regimens; however, we cannot analyze this in more detail retrospectively. Furthermore, we provide no information about the periprocedural use of sedative agents (type, dosage), further need of intensive care treatment, the duration of mechanical ventilation, and the reason for conversion from GA to CS. Apart from the vital signs at admission, there are no extensive data on the course of these vital signs and their impact on complications and outcome. Further, the CS-group also included patients who only received local anesthesia as a distinction between local anesthesia and CS was not made in the GSR-ET register.

Conclusions

Our study showed an influence on the functional and clinical outcome after MT by the choice of anesthesia regimen with advantages for CS compared to GA in terms of complications, functional outcome, and mortality.

https://doi.org/10.5853//jos.2020.02404

Supplementary materials

Supplementary materials related to this article can be found online at https://doi.org/10.5853/jos.2020.02404.

Disclosure

Thomas Liebig consults for Stryker Neurovascular GmbH and has received speaker honoraria from Pfizer, Covidien, Phenox, and Microvention outside this study.

Lars Kellert has received funding for travel or speaker honoraria from Bayer Vital, Boehringer Ingelheim, Bristol-Meyer-Squibb, Daiichi Sankyo, and Pfizer outside of this study.

Acknowledgments

The authors thank Katie Göttlinger and J Stuart Lund for proofreading the manuscript.

References

1. Schönenberger S, Hendén PL, Simonsen CZ, Uhlmann L, Klose C, Pfaff JAR, et al. Association of general anesthesia vs procedural sedation with functional outcome among patients with acute ischemic stroke undergoing thrombectomy: a systematic review and meta-analysis. *JAMA* 2019;322:1283-1293.
2. Campbell BCV, van Zwam WH, Goyal M, Menon BK, Dippel DWJ, Demchuk AM, et al. Effect of general anaesthesia on functional outcome in patients with anterior circulation ischaemic stroke having endovascular thrombectomy versus standard care: a meta-analysis of individual patient data. *Lancet Neurol* 2018;17:47-53.
3. Cappellari M, Pracucci G, Forlivesi S, Saia V, Nappini S, Nencini P, et al. General anesthesia versus conscious sedation and local anesthesia during thrombectomy for acute ischemic stroke. *Stroke* 2020;51:2036-2044.
4. Wollenweber FA, Tiedt S, Alegiani A, Alber B, Bangard C, Berrouschot J, et al. Functional outcome following stroke thrombectomy in clinical practice. *Stroke* 2019;50:2500-2506.
5. Alegiani AC, Dorn F, Herzberg M, Wollenweber FA, Kellert L, Siebert E, et al. Systematic evaluation of stroke thrombectomy in clinical practice: the German stroke registry endovascular treatment. *Int J Stroke* 2019;14:372-380.
6. Ringleb PA, Hamann GF, Röther J, Jansen O, Groden C, Veltkamp R. Akuttherapie des ischämischen schlaganfalls: rekanalisierende therapie [Therapy of acute ischemic stroke: recanalisation therapy guideline]. *Aktuelle Neurol* 2016;43:82-91.
7. Turc G, Bhogal P, Fischer U, Khatri P, Lobotesis K, Mazighi M, et al. European Stroke Organisation (ESO)-European Society for Minimally Invasive Neurological Therapy (ESMINT) guidelines on mechanical thrombectomy in acute ischemic stroke. *J Neurointerv Surg* 2019;11:535-538.
8. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al. 2018 Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke* 2018;49:e46-e110.
9. Bekelis K, Missios S, MacKenzie TA, Tjoumakaris S, Jabbour P. Anesthesia technique and outcomes of mechanical thrombectomy in patients with acute ischemic stroke. *Stroke* 2017;48:361-366.
10. Powers CJ, Dornbos D 3rd, Mlynash M, Gulati D, Torbey M, Nimjee SM, et al. Thrombectomy with conscious sedation compared with general anesthesia: a DEFUSE 3 analysis. *AJNR Am J Neuroradiol* 2019;40:1001-1005.
11. Shan W, Yang D, Wang H, Xu L, Zhang M, Liu W, et al. General anesthesia may have similar outcomes with conscious sedation in thrombectomy patients with acute ischemic stroke: a real-world registry in China. *Eur Neurol* 2018;80:7-13.
12. Goldhoorn RB, Bernsen MLE, Hofmeijer J, Martens JM, Lingsma HF, Dippel DWJ, et al. Anesthetic management during endovascular treatment of acute ischemic stroke in the MR CLEAN Registry. *Neurology* 2020;94:e97-e106.
13. Berkhemer OA, Fransen PS, Beumer D, van den Berg LA, Lingsma HF, Yoo AJ, et al. A randomized trial of intraarterial treatment for acute ischemic stroke. *N Engl J Med* 2015;372:11-20.
14. Flottmann F, Leischner H, Broocks G, Faizy TD, Aigner A, Deb-Chatterji M, et al. Emergency conversion to general anesthesia is a tolerable risk in patients undergoing mechanical thrombectomy. *AJNR Am J Neuroradiol* 2020;41:122-127.
15. Ren C, Xu G, Liu Y, Liu G, Wang J, Gao J. Effect of conscious sedation vs. general anesthesia on outcomes in patients undergoing mechanical thrombectomy for acute ischemic stroke: a prospective randomized clinical trial. *Front Neurol* 2020;11:170.
16. Schönenberger S, Uhlmann L, Hacke W, Schieber S, Mundiyanapurath S, Purrucker JC, et al. Effect of conscious sedation vs general anesthesia on early neurological improvement among patients with ischemic stroke undergoing endovascular thrombectomy: a randomized clinical trial. *JAMA* 2016;316:1986-1996.
17. Simonsen CZ, Sørensen LH, Juul N, Johnsen SP, Yoo AJ, Andersen G, et al. Anesthetic strategy during endovascular therapy: general anesthesia or conscious sedation? (GOLIATH

- General or Local Anesthesia in Intra Arterial Therapy): a single-center randomized trial. *Int J Stroke* 2016;11:1045-1052.
18. Petersen NH, Ortega-Gutierrez S, Wang A, Lopez GV, Strander S, Kodali S, et al. Decreases in blood pressure during thrombectomy are associated with larger infarct volumes and worse functional outcome. *Stroke* 2019;50:1797-1804.
19. Mundiyanapurath S, Stehr A, Wolf M, Kieser M, Möhlenbruch M, Bendszus M, et al. Pulmonary and circulatory parameter guided anesthesia in patients with ischemic stroke undergoing endovascular recanalization. *J Neurointerv Surg* 2016;8:335-341.
20. Kety SS, Schmidt CF. The effects of altered arterial tensions of carbon dioxide and oxygen on cerebral blood flow and cerebral oxygen consumption of normal young men. *J Clin Invest* 1948;27:484-492.
21. Brinjikji W, Murad MH, Rabinstein AA, Cloft HJ, Lanzino G, Kallmes DF. Conscious sedation versus general anesthesia during endovascular acute ischemic stroke treatment: a systematic review and meta-analysis. *AJNR Am J Neuroradiol* 2015;36:525-529.

https://doi.org/10.5853//jos.2020.02404

Appendix 1. GSR investigators

Name	Degree	Organization	Role	Contribution
Tobias Boeckh-Behrens	MD	Klinikum r.d.Isar, Munich, Germany	Site Investigator	German Stroke Registry - Steering Committee
Silke Wunderlich	MD	Klinikum r.d.Isar, Munich, Germany	Site Investigator	German Stroke Registry - Steering Committee
Arno Reich	MD	Uniklinik RWTH Aachen, Germany	Site Investigator	German Stroke Registry - Steering Committee
Anastasios Mpotsaris	MD	Uniklinik RWTH Aachen, Germany	Site Investigator	German Stroke Registry - Steering Committee
Martin Wiesmann	MD	Uniklinik RWTH Aachen, Germany	Site Investigator	German Stroke Registry - Steering Committee
Ulrike Ernemann	MD	Tübingen University Hospital, Germany	Site Investigator	German Stroke Registry - Steering Committee
Till-Karsten Hauser	MD	Tübingen University Hospital, Germany	Site Investigator	German Stroke Registry - Steering Committee
Christian H Nolte	MD	Charite Campus Benjamin Franklin	Site Investigator	German Stroke Registry - Steering Committee
Eberhard Siebert	MD	Charité – Campus Benjamin Franklin und Campus Charité Mitte, Berlin, Germany	Site Investigator	German Stroke Registry - Steering Committee
Sarah Zweynert	MD	Charité - Campus Virchow Klinikum, Berlin, Germany	Site Investigator	German Stroke Registry - Steering Committee
Georg Bohner	MD	Charité - Campus Virchow Klinikum, Berlin, Germany	Site Investigator	German Stroke Registry - Steering Committee
Alexander Ludolph	MD	Sana Klinikum Offenbach, Germany	Site Investigator	German Stroke Registry - Steering Committee
Karl-Heinz Henn	MD	Sana Klinikum Offenbach, Germany	Site Investigator	German Stroke Registry - Steering Committee
Waltraud Pfeilschifter	MD	Uniklinik Frankfurt/ Main, Germany	Site Investigator	German Stroke Registry - Steering Committee
Marlis Wagner	MD	Uniklinik Frankfurt/ Main, Germany	Site Investigator	German Stroke Registry - Steering Committee
Joachim Röther	MD	Asklepios Klinik Altona, Hamburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Bernd Eckert	MD	Asklepios Klinik Altona, Hamburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Jörg Berrouschot	MD	Klinikum Altenburger Land, Altenburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Albrecht Bormann	MD	Klinikum Altenburger Land, Altenburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Anna Alegiani	MD	University Medical Center Hamburg-Eppendorf, Hamburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Jens Fiehler	MD	University Medical Center Hamburg-Eppendorf, Hamburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Fabian Flottmann	MD	University Medical Center Hamburg-Eppendorf, Hamburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Christian Gerloff	MD	University Medical Center Hamburg-Eppendorf, Hamburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Götz Thomalla	MD	University Medical Center Hamburg-Eppendorf, Hamburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Elke Hattingen	MD	University Hospital Bonn, Germany	Site Investigator	German Stroke Registry - Steering Committee
Gabor Petzold	MD	University Hospital Bonn, Germany	Site Investigator	German Stroke Registry - Steering Committee
Sven Thonke	MD	Klinikum Hanau, Germany	Site Investigator	German Stroke Registry - Steering Committee
Christopher Bangard	MD	Klinikum Hanau, Germany	Site Investigator	German Stroke Registry - Steering Committee
Christoffer Kraemer	MD	Klinikum Lüneburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Martin Dichgans	MD	Ludwig Maximilian University of Munich, Germany	Site Investigator	German Stroke Registry - Steering Committee
Marios Psychogios	MD	Georg-August-Universität Göttingen, Germany	Site Investigator	German Stroke Registry - Steering Committee
Jan Liman	MD	Georg-August-Universität Göttingen, Germany	Site Investigator	German Stroke Registry - Steering Committee
Martina Petersen	MD	Klinikum Osnabrück, Germany	Site Investigator	German Stroke Registry - Steering Committee
Florian Stögbauer	MD	Klinikum Osnabrück, Germany	Site Investigator	German Stroke Registry - Steering Committee
Peter Kraft	MD	University Hospital Würzburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Mirko Pham	MD	University Hospital Würzburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Michael Braun	MD	Bezirkskrankenhaus Günzburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Gerhard F. Hamann	MD	Bezirkskrankenhaus Günzburg, Germany	Site Investigator	German Stroke Registry - Steering Committee
Andreas Kastrup	MD	Klinikum Bremen Mitte, Germany	Site Investigator	German Stroke Registry - Steering Committee
Christian Roth	MD	Klinikum Bremen Mitte, Germany	Site Investigator	German Stroke Registry - Steering Committee
Klaus Gröschel	MD	University Medical Center Mainz, Germany	Site Investigator	German Stroke Registry - Steering Committee
Timo Uphaus	MD	University Medical Center Mainz, Germany	Site Investigator	German Stroke Registry - Steering Committee
Volker Limmroth	MD	Kliniken Köln, Germany	Site Investigator	German Stroke Registry - Steering Committee

Supplementary Table 1. Characteristics of GSR patients with anterior circulation stroke comparing the anesthesia regimen (n=5,808 patients, unknown in n=256)

Characteristic	Conscious sedation (n=1,572, 27.1%)	General anesthesia (n=3,786, 65.2%)	Conversion (n=194, 3.3%)	*P*
Age (yr)	73.4±13.0	73.4±13.0	72.0±12.8	0.168
Female sex	799 (50.8)	1,984 (52.4)	98 (50.5)	0.516
Clinical characteristics at admission				
pmRS	0 (0–1) (missing in n=42)	0 (0–1) (missing in n=281)	0 (0–1) (missing in n=13)	0.014
pmRS ≤1	1,222 (77.7)	2,737 (72.3)	150 (77.3)	0.002
Baseline NIHSS	14 (9–17)	15 (10–19)	15 (10–19)	<0.001
Drip and ship	773 (49.2)	1,564 (41.3)	94 (48.5)	<0.001
Admission BP systolic	154.4±27.5	151.1±–27.2	154.1±27.6	<0.001
Admission BP diastolic	84.1±16.9	82.2±16.8	85.6±15.9	<0.001
Admission heartrate	81.9±18.2	81.9±19.4	84.3±18.7	0.111
OAC at admission	315 (20.0)	787 (20.8)	32 (16.5)	0.067
Risk factors				
Arterial hypertension	1,165 (74.1)	2,774 (73.3)	139 (71.6)	0.004
Diabetes mellitus	326 (20.7)	792 (20.9)	42 (21.6)	0.459
Hypercholesterolemia	512 (32.6)	1,509 (39.9)	69 (35.6)	<0.001
Current smoking	197 (12.5)	513 (13.5)	35 (18.0)	<0.001
Atrial fibrillation	637 (40.5)	1,550 (40.9)	74 (38.1)	0.082
Imaging data				
ASPECTS	9 (7–10)	9 (7–10)	8 (7–10)	0.010
Tandem lesion	216 (13.7)	598 (15.8)	37 (19.1)	0.020
Right-sided occlusion	791 (50.3)	1,728 (45.7)	85 (43.8)	0.001
Time intervals (min)				
Admission to groin	60.0 (39.0–88.0)	70.0 (47.0–100.0)	60.0 (41.0–81.0)	<0.001
Groin to flow restoration	39.0 (25.0–63.0)	41.0 (26.0–65.0)	64.0 (42.0–100.0)	<0.001
Admission to flow restoration	106.0 (75.0–142.0)	118.0 (88.0–159.0)	129.0 (97.0–179.0)	<0.001
Treatment				
IVT treatment	809 (51.5)	1,910 (50.4)	121 (62.4)	0.005
Additive medication during thrombectomy	313 (19.9)	1,305 (34.5)	44 (22.7)	<0.001
ASA	16 (1.0)	84 (2.2)	5 (2.6)	0.010
Clopidogrel	2 (0.1)	11 (0.3)	1 (0.5)	0.420
Ticagrelor	0 (0)	16 (0.4)	1 (0.5)	0.034
Tirofiban	18 (1.1)	84 (2.2)	8 (4.1)	0.003
Abciximab	12 (0.8)	0 (0)	0 (0)	1.000
Heparin	218 (13.9)	912 (24.1)	24 (12.4)	<0.001
rtPA	43 (2.7)	78 (2.1)	6 (3.1)	0.239
Acute treatment ipsilateral ICA (stenting and/or PTA)	167 (10.6)	526 (13.9)	25 (12.9)	0.015
No. of passages	2.0±1.6	2.2±1.9	2.5±1.9	<0.001
Periprocedural complications	230 (14.6)	802 (21.2)	57 (29.4)	<0.001
Device malfunction	8 (0.5)	18 (0.5)	2 (1.0)	0.557
Dissection, perforation	41 (2.6)	105 (2.8)	11 (5.7)	0.049
Clot migration, embolization	54 (3.4)	154 (4.1)	9 (4.6)	0.480
ICH	29 (1.8)	111 (2.9)	12 (6.2)	<0.001

https://doi.org/10.5853//jos.2020.02404

Supplementary Table 1. Continued

Characteristic	Conscious sedation (n=1,572, 27.1%)	General anesthesia (n=3,786, 65.2%)	Conversion (n=194, 3.3%)	*P*
Vasospasm	56 (3.6)	344 (9.1)	20 (10.3)	<0.001
Other	108 (6.9)	220 (5.8)	22 (11.3)	0.005
Successful reperfusion mTICI 2b/3	1,303 (82.9)	3,192 (84.3)	162 (83.5)	0.117
24-hr Follow-up				
mRS	4 (3–5) (missing in n=86)	5 (3–5) (missing in n=411)	5 (4–5) (missing in n=29)	<0.001
NIHSS	8 (4–16)	11 (5–19)	14 (5–22)	<0.001
Complications	682 (43.4)	1,765 (46.6)	103 (53.1)	0.012
Malignant middle cerebral artery infarction	67 (4.3)	278 (7.3)	15 (7.7)	<0.001
Recurrent stroke	56 (3.6)	203 (5.4)	4 (2.1)	0.004
ICH	184 (11.7)	669 (15.0)	44 (22.7)	<0.001
Groin haematoma	34 (2.2)	55 (1.5)	7 (3.6)	0.384
Groin aneurysma	14 (0.9	26 (0.7)	1 (0.5)	0.381
Other complications	412 (26.2)	1,055 (27.9)	61 (31.4)	0.104
Hospital stay	9.5±7.4	11.3±9.7	11.2±8.3	<0.001
Discharge				0.561
mRS	4 (2–5) (missing in n=17)	4 (2–5) (missing in n=274)	4 (2–5) (missing in n=9)	<0.001
NIHSS	4 (1–11)	5 (2–12)	6 (2–13)	0.024
Mortality (mRS 6)	180 (11.5)	625 (16.5)	22 (12.0)	<0.001

Values are presented as mean±standard deviation, number (%), or median (interquartile range).
GSR, German Stroke Registry; pmRS, pre-stroke modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; BP, blood pressure; OAC, oral anticoagulation; ASPECTS, Alberta Stroke Program Early CT Score; IVT, intravenous thrombolysis; ASA, acetylsalicylic acid; rtPA, recombinant tissue plasminogen activator; ICA, internal carotid artery; PTA, percutaneous transluminal angioplasty; ICH, intracerebral hemorrhage; mTICI, modified thrombolysis in cerebral infarction; mRS, modified Rankin Scale.

Supplementary Table 2. Logistic regression for good outcome in anterior circulation stroke patients at follow-up

Variable	OR	95% CI	*P*
Age	0.95	0.95–0.96	<0.001
Sex	0.99	0.84–1.15	0.859
pmRS	0.51	0.47–0.56	<0.001
NIHSS at admission	0.88	0.86–0.89	<0.001
Treatment with IVT	1.57	1.35–1.84	<0.001
Successful reperfusion (mTICI 2b/3)	5.41	4.15–7.05	<0.001
General anesthesia	0.86	0.74–0.99	0.041
ICH	0.25	0.20–0.31	<0.001
Time groin to flow restoration	0.99	0.99–1.00	0.009

OR, odds ratio; CI, confidence interval; pmRS, pre-stroke modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; IVT, intravenous thrombolysis; mTICI, modified thrombolysis in cerebral infarction; ICH, intracerebral hemorrhage.

Supplementary Table 3. Logistic regression for mortality in anterior circulation stroke patients at follow-up

Variable	OR	95% CI	*P*
Age	1.07	1.06–1.07	<0.001
Sex	0.88	0.75–1.04	0.126
pmRS	1.37	1.29–1.46	<0.001
NIHSS at admission	1.10	1.09–1.12	<0.001
Treatment with IVT	0.67	0.57–0.79	<0.001
Successful reperfusion (mTICI 2b/3)	0.28	0.23–0.34	<0.001
General anesthesia	1.38	1.19–1.61	<0.001
ICH	2.73	2.26–3.31	<0.001
Time admission to groin	1.00	1.00–1.00	0.323

OR, odds ratio; CI, confidence interval; pmRS, pre-stroke modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; IVT, intravenous thrombolysis; mTICI, modified thrombolysis in cerebral infarction; ICH, intracerebral hemorrhage.

https://doi.org/10.5853//jos.2020.02404