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International Controlled Study of Revascularization and Outcomes Following COVID-Positive Mechanical Thrombectomy

Running Title: Thrombectomy in COVID-19 Patients: Controlled Study

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Abstract

Background: Previous studies suggest that the mechanisms and outcomes in COVID-19-associated stroke differ from those with non-COVID-19 strokes, but there is limited comparative evidence focusing on these populations. Therefore, we aimed to determine if a significant association exists between COVID-19 status with revascularization and functional outcomes following thrombectomy for large vessel occlusion (LVO), after adjustment for potential confounding factors.

Methods: A cross-sectional, international multicenter retrospective study of consecutively admitted COVID-19 patients with concomitant acute LVO, compared to a control group without COVID-19. Data collected included age, gender, comorbidities, clinical characteristics, details of the involved vessels, procedural technique, and various outcomes. A multivariable adjusted analysis was conducted.

Results: In this cohort of 697 patients with acute LVO, 302 had COVID-19 while 395 patients did not. There was a significant difference ($p<0.001$) in the mean age (in years) and gender of patients, with younger patients and more males in the COVID-19 group. In terms of favorable revascularization (mTICI 3), COVID-19 was associated with lower odds of complete revascularization [OR=0.33; 95% CI=0.23-0.48; $p<0.001$], which persisted on multivariable modelling with adjustment for other predictors [aOR=0.30; 95% CI=0.12-0.77; $p=0.012$]. Moreover, endovascular complications, in-hospital mortality, and length of hospital stay were significantly higher among COVID-19 patients ($p<0.001$).

Conclusion: COVID-19 was an independent predictor of incomplete revascularization and poor functional outcome in patients with stroke due to LVO. Furthermore, COVID-19 patients with LVO were more often younger and suffered higher morbidity/mortality rates.

Keywords: COVID-19; Stroke; large vessel occlusion; mortality; morbidity

Introduction

Since the first reported case in Wuhan, China, Coronavirus Disease 2019 (COVID-19) has been prevalent globally, with ~45 million cases and ~730 thousand deaths in the United States, up to October 8, 2021.[1] According to the World Health Organization (WHO), there have been over 241 million cases and almost 5 million deaths worldwide.[2] Patients with COVID-19 are at higher risk of thrombotic events, with a prevalence rate estimated to be 22 %, and can further increase up to 43 % after admission to the intensive care unit.[3] The hypercoagulability in COVID-19 patients may be caused by disease-associated stasis, cytokine storm, dysfunctional endothelium, and platelet activation.[3-5]

One form of thrombosis is acute ischemic stroke (AIS). The risk of AIS in COVID-19 patients may be elevated up to ~3-8-fold in the first three days of respiratory symptoms.[6, 7] The reported prevalence of stroke among COVID-19 patients varies from 1.3% up to 4.9% and the rate of SARS CoV-2 infection among stroke admissions is estimated 3.3%.[8-16] While there have been a number of reports indicating an excess number of large vessel occlusion (LVO) strokes in patients with COVID-19,[8, 17, 18] there are limited data on the safety and outcomes of acute revascularization of LVO in COVID-19 patients.[19, 20] To address current limitations, an international multicenter study was conducted to identify differences in demographics and stroke characteristics of LVO patients with COVID-19 compared to without COVID-19. Furthermore, we sought to further evaluate whether COVID-19 has an independent association with revascularization and functional outcomes following the endovascular treatment.

Materials and methods

An international multicenter retrospective study of consecutively admitted COVID-19 patients was performed with concomitant acute LVOs between February 25 and December 30, 2020, across 50 international comprehensive stroke centers, from North America, Europe and the Middle East.

The institutional review boards of participating institutions reviewed and approved the study, and patient consent was waived based on the de-identified retrospective protocol with minimal risk. Diagnosis of COVID-19 was established using reverse-transcriptase–polymerase-chain-reaction assays of nasopharyngeal samples for identification of SARS-CoV-2. Data will be made available to a qualified investigator upon reasonable request with the corresponding author.

Data Collection

Data collected included age, gender, comorbidities, clinical characteristics of the included COVID-19 patients, details of the involved vessels, procedural technique, and selected outcome measures (e.g., symptomatic intracerebral hemorrhage). Onset to admission time was defined as the time from stroke onset to hospital arrival. Procedure duration was calculated as the time difference between arterial access and sheath removal. COVID-19 severity was determined based on the score and classification provided by the World Health Organization (WHO) [21]. In addition, the classification of acute ischemic stroke subtype was performed according to the Trial of Org 10172 in Acute Stroke Treatment (TOAST) classification [22]. For the involved vessels, we used the same classification provided by our participating centers based on what was reported as first, second, third, and forth.

Study End Points

Co-primary outcomes were: 1) optimal revascularization defined as modified Thrombolysis In Cerebral Infarction (mTICI) grade 3; 2) unfavorable functional outcome at discharge and 90 days defined as modified Rankin Scale (mRS) score 3-6; 3) mortality at 90 days. Recanalization scoring was estimated without central imaging adjudication. Secondary outcomes were: 1) symptomatic intracerebral hemorrhage (sICH) defined as reduction in the National Institute of Health Stroke Scale (NIHSS) by four points in association with any hemorrhage, at the judgment of the treating clinician; 2) NIHSS 24 hours following MT.

Statistical Analysis

All data were analyzed using R software version 4.1.1 using the packages "Rcmdr" and "glm2"[23]. Continuous variables are shown as means and standard deviation, with skewness and kurtosis tests used to evaluate the normal distribution, with comparisons made according to COVID-19 status (COVID-19 vs. non-COVID-19) using independent t-test or Mann-Whitney U test, as appropriate. Categorical variables are reported as frequencies and percentages, with the chi-square test or Fischer exact test used for comparisons, as appropriate. Finally, univariable logistic regression was used to test covariates predictive of revascularization (TICI 2b or 3), and unfavorable outcome (mRS 3-6). Interaction and confounding were assessed through stratification and relevant expansion covariates. Whenever possible, factors predictive on univariable analysis ($p<0.05$) were entered into a backward multivariable logistic regression analysis, and the effect of COVID-19 was assessed as clinically relevant in all models. Regression results were expressed as odds ratios (ORs) and 95% confidence intervals (95% CI). A p value < 0.05 was considered significant for all statistical tests. The results presented here are reported in accordance with

Strengthening the Observational Reporting of Observational Studies Guidelines. Missing data were not imputed.

Data availability

The relevant anonymized patient-level data are available on reasonable request from the authors.

Results

The total cohort composite was 697 patients with LVO, 302 of whom had concomitant COVID-19 (43.3%). Patients with COVID-19 had a younger mean age than those without COVID-19 (61.1 $\pm$15.7 years vs. 71.0 $\pm$ 15.8 years; $p<0.001$), with a lower proportion of female patients in the COVID-19 group (41.1% vs. 80.5%; $p<0.001$). The functional status prior to stroke onset was significantly different, with a lower proportion of functional independence in the COVID-19 group (mRS 0-2: 65.6% vs. 96.2%; $p<0.001$) **(Table 1)**.

Comorbidities

Chronic heart disease (18.9% vs. 34.4%; $p<0.001$) and atrial fibrillation (21.2% vs. 38.2%; $p<0.001$) were less common in patients with COVID-19, while chronic liver disease (6.0% vs. 2.5%; $p=0.022$) and diabetes mellitus type II (29.5% vs. 22.3%; $p= 0.014$) were more common. Hypertension, chronic lung disease, and chronic kidney disease frequency were not different between groups **(Table 1)**.

COVID-19 Characteristics

The severity of COVID-19 at stroke onset was moderate in 73.3% of cases, severe in 14.8% and critical in 11.9%. Cough was the most frequent presenting symptom (48.7%), followed by fever (45.9%), pneumonia (14.4%), and acute respiratory distress syndrome (20.0%). COVID-19 diagnosis was established in 66.1% of the patients prior to stroke onset. The mean duration between COVID-19 symptoms and stroke onset was 8.8 days $\pm$ 11.4; and 33.9% of the COVID-19 group had stroke as the initial manifestation of the COVID-19 disease.

Stroke Characteristics

Cardioembolic etiology represented a lower proportion in the COVID-19 group (12.9% vs. 49.6%), while large vessel atherosclerosis (37.6% vs. 16.5%) and cryptogenic stroke (16.8% vs. 0.0%) were observed at a higher proportion in the COVID-19 group ($p<0.001$). The mean Albert Stroke Program Early Computed Tomography Score (ASPECTS) score at admission was lower in the COVID-19 group (7.8 $\pm$ 2.4 vs. 8.9 $\pm$ 1.5; $p<0.001$). The mean number of involved vessels was comparable between COVID-19 and non-COVID-19 groups (1.4 $\pm$ 0.9 vs. 1.3 $\pm$ 0.5; $p=0.236$). A detailed distribution of affected vessels is shown in **Table 2**.

Stroke Treatment

The mean duration (in minutes) of last known normal to access was shorter in the COVID-19 group (357.4 $\pm$ 513.3 vs. 474.4 $\pm$ 365.1; $p=0.009$), while the mean door to arterial access duration (in minutes) was longer among the COVID-19 group (87.5 $\pm$ 63.5 vs. 71.6 $\pm$ 80.0; $p=0.043$). Intravenous tissue plasminogen activator (tPA) administration was less common in the COVID-19 group (23.5% vs. 33.4%; $p<0.001$). A higher proportion of mechanical thrombectomy procedures were performed under general anesthesia in the COVID-19 group (31.5% vs. 19.1%; $p< 0.001$), while mean thrombectomy pass number (1.8 $\pm$ 1.5 vs. 1.9 $\pm$ 1.2; $p=0.520$), first pass effect (53.3% vs. 49.1%; $p=0.395$), and stenting rates (7.3% vs.

8.6%; p=0.584) were comparable among the two groups **(Table 3)**. The mean procedure duration to achieve revascularization was prolonged in the COVID-19 group (62.2 ± 47.3 vs. 51.9 ± 31.9; p=0.002). Moreover, there was a higher proportion of mTICI 3 outcomes in the control group (66.6% vs. 25.5%; p<0.001) **(Table 3)**.

Complications, Functional Outcomes, and Mortality

The procedure-related complication rate was higher among COVID-19 patients (26.6% vs. 10.0%; p<0.001), with 19.7% of the complications in the COVID-19 group being symptomatic. There was neither a significant difference in sICH (6.6% vs. 5.6%; p=0.683) nor in NIHSS score at 24 hours post thrombectomy (11.9 ± 10.8 vs. 12.2 ± 8.2; p=0.807) between COVID-19 and non-COVID-19 groups.

The length of hospital stay was longer in the COVID-19 group (15.5 ± 17.6 days vs. 8.4 ± 8.5 days; p<0.001). Poor functional outcome (mRS 3-6) at discharge was observed in a significantly higher proportion in the COVID-19 group (37.1% vs. 9.6%; p<0.001), and favorable functional outcome (mRS 0-2) at 90-day follow-up was observed in a lower proportion of COVID-19 vs. non-COVID-19 (10.6% vs 59.0%; p< 0.001) patients. Similarly, the mortality rate was more than two-fold higher in the COVID-19 group (42.0% vs. 19.1; p≤0.001) **(Table 3)**.

Predictors of Revascularization mTICI 3

In the univariable model, absence of COVID-19 infection (OR=0.33; 95% CI=0.23-0.48; p<0.001), female gender (OR=2.56; 95% CI=1.78-3.69; p<0.001), and higher ASPECTS score (OR=1.15; 95% CI=1.04-1.27; p=0.007) were predictors of better revascularization (mTICI 3). Accounting for other possible cofounders, only COVID-19 status (OR=0.30; 95%

CI= 0.12-0.77; p=0.012) and female sex (OR=2.83; 95% CI=1.31-6.15; p=0.008) were independent predictors **(Table 4)**.

Predictors of Unfavorable Outcomes (mRS 3-6)

Unfavorable outcomes were higher with increasing age (OR=1.04; 95% CI=1.02-1.06; p<0.001) and NIHSS score at admission (OR=1.10; 95% CI=1.06-1.15; p<0.001). Accounting for possible confounders (including pre-admission mRS), age (OR=1.04; 95% CI= 1.02-1.06; p< 0.001) and NIHSS score (OR= 1.10; 95% CI= 1.06-1.15; p< 0.001) persisted as independent risk factors for unfavorable outcomes **(Table 5)**. A sensitivity analysis including only patients with a pre-admission mRS of 0-2, found higher rates of unfavorable outcome among COVID-19 patients at three months (OR= 2.10; 95% CI= 1.08-3.99; p=0.025); however, this association was not significant after controlling for other variables (OR=0.81; 95% CI= 0.22-2.59; p=0.731) **(Supplementary Table 1)**. A summary of predictors of mTICI 3 and mRS 3-6 are presented in **Supplementary Figure 1.**

Discussion

Our global collaborative effort to pool data on patients with large vessel occlusion during the COVID-19 pandemic provided us the opportunity to explore the impact of COVID-19 on interventional outcomes in this population. From analyses of compiled cases from 50 institutions worldwide, our data support that COVID-19 patients with concomitant LVO have poorer functional outcome and rates of revascularization compared to non-COVID-19 patients, with a mortality rate reaching up to 42%. The likelihood of achieving complete revascularization was reduced by 70% compared to patients without COVID-19, in our collaboration. Our data are supported by contemporary reports of poorer outcomes in patients

with AIS in the setting of COVID-19, albeit without controls, which is a key advantage of our current report.[24-30] Similar to the present study, other analyses also support that COVID-19 is an independent predictor of LVO, less favorable functional outcome at follow-up, and increased mortality.[19, 30-33]

The underlying pathophysiology that drives poorer outcomes for AIS in COVID-19 patients is subject to ongoing investigation. However, it is likely that COVID-19 influences patient conditioning for recovery post-stroke. Factors known to impede recovery post-stroke include patient demographic factors, baseline functional status, and comorbidities[34]. In addition, stroke characteristics including severity and extent of stroke, location of ischemic tissue, time lag to treatment, concomitant pathologies, and other complications all affect post-stroke recovery.[34] The physiological state secondary to COVID-19 appears to further exacerbate damage caused by ischemia.[35] In particular, the heightened prothrombotic and pro-inflammatory state of COVID-19 may manifest in several ways, including AIS, vasculopathy, myocarditis, arrhythmias, thrombotic microangiopathy, coagulopathy and thrombocytopenia, tropism to endothelial cells via ACE-2 receptor, and inhibition of angiotensin (1-7) production.[36-61] It has been proposed that downregulation of ACE-2 leading to both arteriopathy and thrombosis may play a central role in the development of stroke during COVID-19.[62-64]

Understanding the characteristics of patients who develop LVO in the setting of COVID-19 is important for prognosis and immediate care. To achieve this goal, we performed one of the first comparative studies of COVID-19 and control patients with LVO. We found that the mean age of the COVID-19 cohort was younger than that of controls by approximately 10 years, which corroborates prior reported findings from other non-controlled studies.[27, 30,

31, 65-70] The latter figures are almost four-fold higher than the general population. We also found a significantly higher representation of males in the COVID-19 group, which is consistent with reported prior non-controlled studies.[28, 30]

Elucidating the impact of COVID-19 on the onset and severity of AIS is also an important consideration in the clinical care of this population. This is pertinent given that 73.3% of the patients who developed LVO with COVID-19 had moderate disease severity according to the WHO classification[21]. Their immune dysregulation may result in a cytokine storm, which is of pathophysiological significance in the development of stroke in COVID-19 disease.[71-73] The time from initial COVID symptomatology to stroke onset was on average 9 days in our study.[74] The Global COVID-19 Stroke Registry reported a similar latency of approximately 7 days between symptom onset and stroke.[30] The interval from symptom onset to hospital presentation was lower in the COVID-19 group, which may be consistent with previous studies that did not show a delay in endovascular thrombectomy time metrics during the COVID-19 era.[75, 76] Factors that can increase the risk of stroke include infection, which can also concurrently worsen the severity of the stroke.[77]

There was a significant difference between stroke classification according to TOAST criteria, with a higher proportion of cryptogenic stroke in the COVID-19 group[22]. In our international experience, we found that stroke severity was generally worse in the COVID-19 cohort compared to controls, based on ASPECTS score, NIHSS score at presentation, and the number of involved vessels. The etiology of strokes for patients with and without COVID-19 were also significantly different. Confirming the preliminary conclusions of smaller non-controlled studies, we found that COVID-19 LVO was associated with higher rates of strokes due to large vessel atherosclerosis or cryptogenic etiology, whereas non-COVID-19 LVO

was more likely to be cardioembolic in etiology[18, 78, 79]. This further supports the suggestion that COVID-19 is a prothrombotic and pro-inflammatory systemic state which may induce LVO. Additionally, the cerebral distribution of strokes was also considerably different. Non-COVID-19 strokes were most frequently observed in the MCA-M1 distribution. However, COVID-19 LVO appeared more likely to occur in the ACA, for reasons that are yet to be elucidated. It should be noted that a non-negligible portion of the occlusion location data was not available in the current study.

When comparing our experience with those of other large analyses, we found that the Get With The Guidelines-Stroke (GWTG-Stroke) registry analysis reported comparable results in patients diagnosed with COVID-19. The authors reported a worse NIHSS score at presentation, and considerably greater proportions of LVO stroke.[31] In our study, the rate of tPA administration was higher amongst non-COVID-19 patients. This may be related to several factors, but one contributor could have been barriers to stroke care for COVID-19 patients. Consistent with other clinical cerebrovascular studies, there was a relative global decline in IV thrombolysis, mechanical thrombectomy, ruptured aneurysm treatment, and aneurysmal SAH admissions during the initial wave of the COVID-19 pandemic [15, 80].

The complexity of intervention and technical approach are other factors to be considered for mechanical thrombectomy for LVO. We assessed relative complexity between COVID-19 and non-COVID-19 groups by comparing indirect measures based on the duration of the procedure, number of vessels involved, number of passes, rate of complete and favorable revascularization, and technical complications. Our analysis suggested that having LVO with COVID-19 was associated with more involved vessels, longer procedure duration, and a lower proportion of complete revascularization at the end of the procedure, albeit with a

similar number of passes per occlusion. Furthermore, COVID-19 patients had a 70% lower likelihood of achieving mTICI 3. Our results are in line with those reported in prior non-controlled COVID-19 series and are consistent with historic MT data[68-70]. A possible explanation is the hypercoagulable state in COVID-19 patients, which may cause re-occlusion. In addition, among the COVID-19 patients undergoing thrombectomy, the intravascular clots were prone to fragment and migrate into both new vascular territories and into distal downstream vasculature, in higher rates than is otherwise typical. However, neither of these possible causes emerged as a pattern or in a frequency high enough to be generalized. A prospective, large-scale trial could help to answer such a question. Although we found the initial admission ASPECTS score to be highly associated with successful revascularization, the association was not significant in the multivariate model. In the same context, time to groin puncture and whether or not tPA was given were also non-influential factors for revascularization in multivariable analysis. Of note, patients with diabetes had 2.78 higher odds of achieving mTICI 3 compared to controls, even after adjustment. The reason for the association with diabetes is unknown but possible hypotheses surround differences in etiology of stroke. Diabetic patients may have received more strict glycemic control, whereas paradoxically non-diabetic patients can encounter iatrogenic hyperglycemia with common COVID treatments such as dexamethasone. As a known inhibitor of fibrinolysis, hyperglycemia on admission was the only independent predictor of failed recanalization after tPA treatment[82, 83].

Finally, we compared follow-up functional outcomes after EVT in patients with COVID-19 versus those without. We found in our combined cohort, that good functional outcome at discharge and follow-up were significantly lower in the COVID-19 group. The mortality rate, when compared to prior published data, was significantly higher. Similarly, the GWTG-

Stroke consortium and the Global COVID-19 Stroke Registry demonstrated that COVID-19 was an independent predictor of poor outcome and death.[30, 31] Other factors such as diabetes and chronic liver disease history, admission ASPECTS score, and tPA use were not associated with poor functional outcome on follow-up. In our cohort, we found that the 24-hour sICH and NIHSS scores were not significantly different with or without COVID-19. However, the former had a prolonged hospital stay, which suggests that other factors prolong the perioperative and subsequent recovery process.

The strengths of this study include that it is the first global multicenter controlled study for LVO in COVID-19. It highlights the value of institutional collaboration in addressing clinical questions in a timely and robust manner. This study is constrained by several limitations. The retrospective design of the study means there is an element of selection bias particularly when patients are chosen for mechanical thrombectomy. Due to the stress on the resources created by the COVID-19 pandemic, some patients may not have received optimal advanced imaging and clinical follow-up, and as such there were missing data for several outcomes. Nevertheless, all missing data are within subsidiary variables. Occasionally, control for some cofounders was not possible due to insufficient data in patient records. Future prospective studies are needed to obtain a higher level of evidence.

Conclusion

COVID-19 is an independent predictor of incomplete revascularization in patients with stroke due to LVO in this controlled study. Patients are more often younger, males, and suffer from higher morbidity/mortality rates.

Data availability statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Contributorship Statement

- Conception or design of the work: AAD, AS, AA, PJ, MP, KB, TNN, JS
- Performing the procedures: NS, ER, MK, MMG, SMN, DKL, AEH, PK, MG, MRL, SE, SM, MS, FC, ME, PPY, ASP, RMS, AM, MW, OSY, DVD, GCD, IL, TNN, MA
- Data acquisition and analysis: AAD, SG, AS, ER, RAT, BH, BH, DV, NV, JS
- Interpretation of data: SG, AAD, AS, KP, ER, JG, JTB, KEN, RA
- Drafting the work: SG, AAD, KP, PJ, AS, NAH
- Revising the work for valuable intellectual content: SG, PH, AAD, RWR, ST, MRG, RHR
- Final approval of the version: All Authors.

Ethical approval: All procedures performed in the studies involving human participants were per the Institutional Review Board (IRB) ethical standards and national research committee and the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent: The study protocol was reviewed and approved by the University Institutional Review Board. Following our institutional guidelines, all protected health information was removed, and individual patient consent was not required in the analysis of this case series.

Supplementary Figure 1. (A) Predictors of mTICI 3 following multivariable adjusted analyses. (B) Predictors of mRS 3-6 following multivariable adjusted analyses. Asterisk on the right indicates significance with P<0.05. CI, confidence interval; mRS, modified Rankin Scale; NIHSS, National Institute of Health Stroke Scale; ASPECTS, Alberta stroke program early CT score; tPA, Tissue Plasminogen Activator.

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Table 1. Baseline characteristics of the patients with large vessel occlusion with and without COVID-19

Variables		Non-COVID-19 (N=395)	COVID-19 (N=302)	Total (N=697)
Age (years)	**Mean (SD)**	71.0 (15.8)	61.1 (15.7)	67.1 (16.5)
Gender	**Female**	318 (80.5)	124 (41.1)	442 (63.4)
Pre-admission mRS score	**0-2**	380 (96.2)	198 (65.6)	578 (82.9)
NIHSS at Admission	**Mean (SD)**	14.3 (7.5)	17.2 (8.5)	15.4 (8.0)
Hypertension		271 (68.8)	174 (57.6)	445 (63.8)
Chronic Heart Disease		136 (34.4)	57 (18.9)	193 (27.7)
Chronic Lung Disease		76 (19.2)	60 (19.9)	136 (19.5)
Chronic Kidney Disease		43 (10.9)	28 (9.3)	71 (10.2)
Chronic Liver Disease		10 (2.5)	18 (6.0)	28 (4.0)
Diabetes Mellitus (type II)		88 (22.3)	89 (29.5)	177 (25.4)

Atrial Fibrillation	151 (38.2)	64 (21.2)	215 (30.8)	
New Onset Atrial Fibrillation	0 (0.0)	21 (7.0)	21 (3.0)	

mRS: Modified Rankin Scale; NIHSS: National Institutes of Health Stroke Scale; SD: standard deviation; * Statistically significant; Missing data count per variable: Age= 53, Gender= 17, Pre-admission mRS score= 70, NIHSS at Admission= 72, Hypertension= 40, Chronic Heart Disease= 24, Chronic Lung Disease= 22, Chronic Kidney Disease= 24, Chronic Liver Disease= 22, Diabetes Mellitus (type II)= 31, Atrial Fibrillation= 31, New Onset Atrial Fibrillation= 417

Table 2. Summary of the included large vessel occlusions

Variables		**Non-COVID-19**	**COVID-19**	
		(N=395)	**(N=302)**	
Stroke Classification	**Large Vessel Atherosclerosis (50% or more narrowing in an artery)**	64 (16.5)	76 (37.6)	
	Cardioembolic	192 (49.6)	26 (12.9)	
	Other (Dissection, Hypercoagulable)	131 (33.8)	66 (32.7)	
	Cryptogenic	0 (0.0)	34 (16.8)	
ASPECTS Score on Admission	**Mean (SD)**	8.9 (1.5)	7.8 (2.4)	
Number of Vessels Involved	**Mean (SD)**	1.3 (0.5)	1.4 (0.9)	
Vessel Involved	**ICA**	35 (9.0)	9 (25.7)	
	MCA (M1 segment)	156 (40.2)	3 (8.6)	
	MCA (M2 segment)	89 (22.9)	3 (8.6)	
	ACA (A1 segment)	4 (1.0)	3 (8.6)	
	ACA (A2 segment)	4 (1.0)	15 (42.9)	
	Extracranial carotid	62 (16.0)	0 (0.0)	
	Basilar	24 (6.2)	2 (5.7)	
	MCA (M3/4 segments)	10 (2.6)	0 (0.0)	
	Vertebral	4 (1.0)	0 (0.0)	
Second Vessel Involved (If more than one)	**ICA**	7 (8.5)	4 (7.4)	
	MCA (M1 segment)	39 (47.6)	10 (18.5)	
	MCA (M2 segment)	18 (22.0)	8 (14.8)	
	ACA (A1 segment)	5 (6.1)	13 (24.1)	
	ACA (A2 segment)	3 (3.7)	4 (7.4)	
	Extracranial carotid	0 (0.0)	3 (5.6)	
	Basilar	1 (1.2)	1 (1.9)	
	PCA	2 (2.4)	6 (11.1)	
	MCA (M3/4 segments)	6 (7.3)	4 (7.4)	
	Vertebral	1 (1.2)	1 (1.9)	
	MCA (M1 segment)	6 (31.6)	2 (50.0)	

Third Vessel Involved (If more than two) ¶	**MCA (M2 segment)**	5 (26.3)	1 (25.0)	
	ACA (A1 segment)	7 (36.8)	0 (0.0)	
	ACA (A2 segment)	1 (5.3)	0 (0.0)	
	PCA	0 (0.0)	1 (25.0)	
Fourth Vessel Involved (If more than three)	**MCA (M1 segment)**	0 (0.0)	8 (42.1)	
	MCA (M2 segment)	3 (100.0)	7 (36.8)	
	ACA (A1 segment)	0 (0.0)	3 (15.8)	
	PCA	0 (0.0)	1 (5.3)	

COVID-19= Coronavirus Disease 2019; ASPECTS: Alberta stroke programme early CT score; ICA: Internal carotid artery; MCA: Middle Cerebral Artery; ACA: Anterior cerebral artery; PCA: Posterior cerebral artery; SD: standard deviation; * Statistically significant; Missing data count per variable: Stroke Classification= 108, ASPECTS= 152, Vessel Involved= 273

Table 3. Summary of the procedures performed and outcomes

Variables		**Non-COVID-19 (N=395)**	**COVID-19 (N=302)**	
Door to Groin (minutes)	**Mean (SD)**	71.6 (80.0)	87.5 (63.5)	7
LKN to Groin (minutes)	**Mean (SD)**	474.4 (365.1)	357.4 (513.3)	
tPA given		132 (33.4)	71 (23.5)	2
Number of passes during thrombectomy	**Mean (SD)**	1.9 (1.2)	1.8 (1.5)	
First Pass Effect		194 (49.1)	161 (53.3)	2
Stenting		34 (8.6)	22 (7.3)	
Procedure duration (minutes)	**Mean (SD)**	51.9 (31.9)	62.2 (47.3)	5
Favorable revascularization (mTICI 2b - 3)		337 (85.3)	154 (50.9)	4
Favorable revascularization (mTICI 3)		263 (66.6)	77 (25.5)	3
Complications during or after the procedure	**None**	352 (90.0)	168 (73.4)	5

	Asymptomatic	39 (10.0)	16 (6.9)	
	Symptomatic	0 (0.0)	45 (19.7)	
sICH		22 (5.6)	20 (6.6)	
NIHSS 24 hours post Thrombectomy	**Mean (SD)**	12.2 (8.2)	11.9 (10.8)	1
mRS at discharge	**0-2**	131 (33.2)	149 (49.3)	2
	3-6	38 (9.6)	112 (37.1)	1
	NA	226 (57.2)	41 (13.6)	2
mRS at 3 months Follow up	**0-2**	233 (59.0)	32 (10.6)	2
	3-6	73 (18.5)	18 (6.0)	
	NA	89 (22.5)	252 (83.4)	3
Length of Hospital Stay (Days)	**Mean (SD)**	8.4 (8.5)	15.5 (17.6)	1
Discharge	**Home**	81 (20.5)	41 (13.6)	1
	Rehabilitation	173 (43.8)	56 (18.5)	2
	Hospice	23 (5.8)	5 (1.7)	
	Nursing Facility	57 (14.4)	17 (5.6)	
	Not reported/deceased	61 (15.4)	183 (60.6)	2
In Hospital Mortality		74 (19.1)	111 (42.0)	1

LKN: Last known normal; tPA: Tissue plasminogen activator; mTICI: Modified treatment in cerebral infarction; sICH : symptomatic intracerebral hemorrhage; mRS: Modified Rankin Scale; SD: standard deviation; NA: not available; * Statistically significant; Missing data count per variable: Door to Groin= 271, LKN to groin= 264, tPA given= 80, Number of passes= 112, First pass effect= 144, Stenting= 65, Procedure duration= 102, Favorable revascularization= 127, Complications= 75, sICH= 373, 24 hours NIHSS= 161, mRS at discharge= 267, mRS at 3 months= 341, Length of Hospital Stay= 92, Discharge= 191

Table 4. Logistic regression for possible predictors of complete revascularization in patients with large vessel occlusion during the COVID-19 pandemic (mTICI 3)

Predictors		Univariable	M
		OR (95% CI)	O
COVID Status	Non- COVID-19	*Reference*	
	COVID-19	0.33 (0.23-0.48, p< 0.001*)	0.30 (0.
Age (years)	Mean (SD)	1.01 (0.99-1.02, p=0.306)	0.99 (0.
Gender	Male	*Reference*	
	Female	2.56 (1.78-3.69, p< 0.001*)	2.83 (1.
Pre-admission mRS	0-2	*Reference*	
	3-6	1.48 (0.71-3.32, p=0.313)	1.69 (0.
NIHSS at Admission	Mean (SD)	0.98 (0.96-1.00, p=0.064)	1.00 (0.
Chronic Liver Disease	No	*Reference*	
	Yes	1.06 (0.41-2.93, p=0.900)	1.39 (0.
Diabetes	No	*Reference*	
	Yes	1.19 (0.81-1.77, p=0.370)	2.78 (1.
ASPECTS Score on Admission	Mean (SD)	1.15 (1.04-1.27, p=0.007*)	1.14 (0.
Door to Groin (minutes)	Mean (SD)	1.00 (0.99-1.00, p=0.065)	1.00 (0.
LKN to Groin (minutes)	Mean (SD)	1.00 (1.00-1.00, p=0.053)	1.00 (1.
tPA given	No	*Reference*	
	Yes	0.92 (0.64-1.31, p=0.634)	0.77 (0.

mRS: Modified Rankin Scale; NIHSS: National Institutes of Health Stroke Scale; ASPECTS: Alberta stroke programme early CT score; LKN: Last known normal; tPA: Tissue plasminogen activator; SD: standard deviation; * Statistically significant

Table 5. Logistic regression for possible predictors of unfavorable outcomes (mRS 3-6)

Predictors		Univariable	
		OR (95% CI)	
COVID Status	Non-COVID	*Referenc*	
	COVID	1.80 (0.94-3.36, p=0.071)	
Age (years)	Mean (SD)	1.04 (1.02-1.06, p< 0.001*)	
Gender	Male	*Referenc*	
	Female	0.96 (0.56-1.69, p=0.887)	
Pre-admission mRS	0-2	*Referenc*	
	3-6	2.58 (0.81-7.98, p=0.096)	
NIHSS at Admission	Mean (SD)	1.10 (1.06-1.13, p< 0.001*)	
Chronic Liver Disease	No	*Referenc*	

	Yes	1.69 (0.43-5.73, p=0.413)
Diabetes	**No**	*Referenc*
	Yes	1.14 (0.64-1.98, p=0.653)
ASPECTS Score on Admission	**Mean (SD)**	0.92 (0.81-1.05, p=0.206)
tPA given	**No**	*Referenc*
	Yes	0.87 (0.51-1.45, p=0.588)

COVID-19: Coronavirus Disease 2019; mRS: Modified Rankin Scale; NIHSS: National Institutes of Health Stroke Scale; ASPECTS: Alberta stroke programme early CT score; tPA: Tissue plasminogen activator; SD: standard deviation; * Statistically significant