Neurological Sciences (2022) 43:4335–4348
https://doi.org/10.1007/s10072-022-05935-x

ORIGINAL ARTICLE

Ischemic stroke and reperfusion therapies in diabetic patients

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Received: 24 October 2021 / Accepted: 3 February 2022 / Published online: 11 February 2022

Abstract

Introduction The study aimed to identify the main prognostic factors in diabetic patients with ischemic stroke undergoing reperfusion therapies (RT).

Methods This retrospective study included 170 diabetic patients: 62 treated with intravenous thrombolysis (IVT) alone and 108 with mechanical thrombectomy (MT). Among MT patients, 29 underwent IVT. We collected clinical, laboratory, and radiological data. The outcomes were 3-month functional impairment (measured by modified Rankin scale, mRs), discharge neurological severity (measured by National Institutes of Health Stroke Scale score, NIHSS), 3-month mortality, intracranial hemorrhage (ICH), and symptomatic intracranial hemorrhage (SICH). We performed a general analysis for all RT and sub-group analyses for IVT and MT.

Results A lower mRs was associated with lower glycemia and admission NIHSS (aNIHSS) in all RT and MT; lower aNIHSS and younger age in IVT. Mortality increased with hyperglycemia, aNIHSS, and age in all RT; age and aNIHSS in IVT; hyperglycemia and systolic pressure in MT. A lower discharge NIHSS was related with lower aNIHSS, thrombolysis, and no thrombectomy in all RT; lower aNIHSS in IVT; lower aNIHSS and thrombolysis in MT. ICH was associated with elevated aNIHSS, older age, and lower platelets in all RT; lower platelets and older age in IVT; higher aNIHSS in MT. SICH depended on longer thrombectomy duration in all RT; no metformin use in IVT; higher weight in MT.

Conclusion The study shed light on diabetic patients and stroke RT highlighting the protective effect of metformin in IVT and the role of glycemia, weight, and combined treatment in MT.

Keywords Ischemic stroke · Diabetes mellitus · Intravenous thrombolysis · Mechanical thrombectomy · Glycemia · Metformin

Introduction

Type 2 diabetes mellitus (T2DM) is a serious public health concern with a considerable impact on human life and health expenditures. About 462 million people suffer from T2DM, corresponding to 6.28% of the world's population. The USA and Western Europe show a higher prevalence rate that continues to rise despite public health interventions [1]. The number of people living with diabetes mellitus quadrupled between 1980 and 2014 [2]. The global prevalence could increase from 6000 to about 8000 per 100,000 by 2040 [1]. T2DM is a major risk factor for cerebrovascular disease; a diabetic patient has more than doubled risk to develop an ischemic stroke (IS) [3]. Diabetes prevalence in IS was estimated to be 33% [4].

Reperfusion therapies (RT) represent a fundamental treatment in acute IS, and diabetes has a considerable influence on the outcome of treated patients [5–8]. Although there are many studies that examined the differences between diabetic and no diabetic patients, only a few evaluated factors determining prognosis among diabetic patients with IS and underwent RT.

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The aims of the present study are to identify the main prognostic factors in diabetics treated with RT and to evaluate the reciprocal influence of intravenous thrombolysis (IVT) and mechanical thrombectomy (MT) among these patients.

Methods

Patients

In this retrospective study, we reviewed 962 acute IS patients treated with IVT and/or MT in our hospital between February 2014 and December 2019, and we selected 170 patients with a previous T2DM diagnosis.

Patients underwent IVT within 4.5 h after IS onset. In case of unknown symptom onset, the IVT was also performed if magnetic resonance imaging (MRI) showed an ischemic lesion on diffusion-weighted imaging (DWI) that was not visible on fluid-attenuated inversion recovery (FLAIR).

Patients underwent MT within a time frame from symptom onset to treatment ≤ 6 h for anterior circulation and ≤ 24 h for posterior circulation. Regarding stroke with unknown onset, patients were selected using MRI in order to discern between salvageable and terminally infarcted tissue with the application of DWI, perfusion scanning, and FLAIR.

Main exclusion criteria for RT were large territorial infarction defined as Alberta Stroke Program Early CT Score (ASPECTS) < 5, hospital arrival beyond time window, and elevated bleeding risk for IVT.

Patients suffering from type 1 diabetes mellitus were excluded from the study.

Data collection and clinical assessment

The following baseline information and risk factors were assessed in all participants: age, gender, weight, smoke, arterial hypertension, dyslipidemia, coronary heart disease, prior stroke or transitory ischemic attack, chronic kidney disease. Collected data regarding T2DM were antidiabetic drugs (metformin/no metformin) and duration of T2DM. Laboratory test data were admission glucose, creatinine, leucocytes, neutrophils, lymphocytes, and platelets. Admission systolic and diastolic pressures were included. Collected stroke data were etiology according to the Trial of Org 10,172 in Acute Stroke Treatment classification [9], IVT, recombinant tissue plasminogen activator (rtPA) dosage, MT, stroke-to-treatment time (interval between first symptom onset and the beginning of IVT or femoral artery puncture), duration of MT treatment (interval between femoral artery puncture and last contrast bolus injection), neurological severity on admission and discharge using the National Institutes of Health Stroke Scale (NIHSS), intracranial hemorrhage (ICH), symptomatic intracranial hemorrhage (SICH) according to the European-Australian Cooperative Acute Stroke Study 2 (ECASS2) [10], 3-month functional impairment using modified Rankin scale (mRs), and 3-month mortality.

Outcome measures

The main outcome is the mRs at 3 months.

The secondary outcomes are:

- Neurological severity on discharge
- 3-month mortality
- ICH
- SICH

All data were retrospectively obtained using our center database and medical charts. We performed a main analysis on all RT and two subanalyses focusing on patients treated with IVT alone and patients underwent MT, respectively.

Ethics approval and study consent

The research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The study protocol had been approved by the research institute's committee on human research. Every patient or a legal representative provided a written informed consent to data collection for scientific purposes.

Statistical analysis

All statistical analyses were performed using R software. Continuous variables were expressed as mean ± standard deviation or median and interquartile range (IQR); categorical variables were expressed as absolute frequencies and percentages. Data were analyzed by Shapiro–Wilk test to evaluate normal distribution. Mann–Whitney *U* or Student's *t* test for independent samples was used for comparison between categorical variables with two levels and continuous variables as appropriate. ANOVA test or Kruskal–Wallis test was used for comparison between categorical variables with more than 2 levels and continuous variables on the basis of normal distribution. The chi-square test was used for comparison between categorical variables. The method of partitioning the degrees of freedom was applied to refuse H0 hypothesis as appropriate. Spearman's Rank or Pearson's correlation coefficient

was used for comparison between continuous variables as appropriate. In multivariate analyses (MA), we used binomial logistic regression model or multiple linear regression model. A binomial logistic regression was used for binary-dependent variables (3-month mortality, ICH and SICH) whereas a multiple linear regression was used for quantitative outcomes (mRs at 3 months and neurological severity on discharge). The goodness of fit tests used were Hosmer–Lemeshow for *C* and *H* statistic, Osius-Rojek's, Stukel's, and Le Cessie-Van Houwelingen-Copas-Hosmer [11]. A value of $P \leq 0.05$ was considered significant.

Results

Descriptive analysis

The study cohort comprised 170 diabetic patients. The mean age was 76.72 years, eighty-four (49.4%) were males, and the median admission NIHSS was 14 (IQR 8–18). The median functional outcome at 3 months measured by mRs was 4 (IQR 2–6). The median discharge NIHSS was 5 (IQR 2–10). Forty-six patients (27.1%) died within 3 months. Fifty-nine patients (34.7%) had an ICH, and fifteen (8.8%) a SICH.

Patients who underwent IVT alone were 62. The mean age was 76.89 years, thirty-three (53.2%) were males, and the median admission NIHSS was 10 (IQR 6–15). The mRs at 3 months was 3 (IQR 1–5). The median discharge NIHSS was 3 (IQR 1–5). Fourteen patients (24.6%) died within 3 months. Twenty-two patients (35.5%) had an ICH, and seven (11.5%) a SICH.

MT was performed in 108 patients. Among these, only 29 patients underwent IVT, whereas the others were not treated in most cases because of delay in hospital arrival and the unknown onset with a no permissive MRI. They had a mean age of 76.62 years, the males were 51 (47.2%), and the median admission NIHSS was 14 (IQR 10.75–18.25). The mRs at 3 months was 4 (IQR 2–6). The median discharge NIHSS was 6 (IQR 3–12). Thirty-two patients (29.6%) died within 3 months; thirty-seven patients (34.3%) had an ICH, and eight (7.4%) a SICH.

The present data, remaining baseline characteristics, and treatment information are summarized in Table 1. Table S1 shows a descriptive analysis of MT patients divided according to treatment with IVT.

Outcome analysis in all patients undergoing reperfusion therapies

A higher 3-month mRs was associated with no metformin use (4 [2–6] vs 3 [1–5]; *p*-value = 0.020), MT (4 [2–6] vs 3 [1–5]; *p*-value = 0.034), older age (correlation coefficient, $r = 0.211$; *p*-value = 0.009), higher admission blood glucose ($r = 0.202$; *p*-value = 0.013), and elevated admission NIHSS ($r = 0.407$; *p*-value = 0.000) (see Table 2). Only admission blood glucose and admission NIHSS maintained statistical significance on MA.

Lower NIHSS on discharge was associated with IVT (5.11 ± 5.50 vs 8.63 ± 6.11; *p*-value = 0.001), no MT (5.19 ± 5.62 vs 7.71 ± 6.10; *p*-value = 0.013), lower neutrophil levels ($r = 0.200$; *p*-value = 0.018), higher lymphocyte levels ($r = -0.199$; *p*-value = 0.018), and lower admission NIHSS ($r = 0.521$; *p*-value = 0.000) (see Table 3). On MA, lower NIHSS on discharge was related only with IVT, no MT, and admission NIHSS.

The 3-month mortality was associated with older age (78.98 ± 8.31 vs 75.41 ± 8.87; *p*-value = 0.021), no smoke (32.0% vs 12.5%; *p*-value = 0.053), elevated admission blood glucose (210.00 ± 81.84 vs 175.67 ± 60.98; *p*-value = 0.005), and a higher admission NIHSS (17.5 [11–20] vs 13 [8–17]; *p*-value = 0.003) (see Table S2). Age, blood glucose, and admission NIHSS were related with mortality on MA.

Patients with ICH were older (78.97 ± 7.90 vs 75.61 ± 8.93; *p*-value = 0.017) and more frequently non-smoker (38.3% vs 16%; *p*-value < 0.031) and they had lower platelet levels ($210{,}574.55 \pm 203{,}000.00$ vs $251{,}046.73 \pm 102{,}239.28$; *p*-value = 0.008) and a higher admission NIHSS (16 [13–19.5] vs 12 [8–17]; *p*-value = 0.001) (see Table 4). MA confirmed age, platelets, and admission NIHSS.

The predictors of SICH were leucocyte levels (7807.86 ± 2981.04 vs 9405.96 ± 2828.66; *p*-value = 0.046), stroke etiology (2.6% of large artery atherosclerosis, 15.5% of cardio embolism, 33.3% of small vessel occlusion, 6.0% of undetermined subtype; *p*-value < 0.051), and duration of MT treatment (151.25 ± 105.11 vs 75.55 ± 38.87; *p*-value = 0.001) (see Table 5). Only MT duration was confirmed on MA.

Outcome analysis in patients undergoing IVT

Analyzing patients undergoing IVT, a lower 3-month mRs was associated metformin (2 [0–4] vs 4 [3–6]; *p*-value = 0.004), younger age ($r = 0.562$; *p*-value = 0.000), short diabetes duration ($r = 0.328$; *p*-value = 0.013), and lower admission NIHSS ($r = 0.538$; *p*-value = 0.000) (see Table 2). Age and admission NIHSS were also confirmed on MA.

A lower NIHSS on discharge was related with younger age ($r = 0.332$; *p*-value = 0.012); metformin use (2 [1–4.75] vs 5.5 [1–12]; *p*-value = 0.031); lower neutrophil levels ($r = 0.330$; *p*-value = 0.013); higher lymphocyte levels

Table 1 Baseline characteristics, treatments, and outcomes

	Overall (170)	Intravenous thrombolysis (62)	Mechanical thrombectomy (108)
Age, years, mean ± SD	76.72 (± 8.72)	76.89 (± 9.57)	76.62 (± 8.24)
Male, *n* (%)	84 (49.4%)	33 (53.2%)	51 (47.2%)
Weight, kg, mean ± SD	73.98 (± 13.71)	72.71 (± 16.19)	75.09 (± 11.11)
Smoke, *n* (%)	26 (15.3%)	10 (16.1%)	16 (14.8%)
Arterial hypertension, *n* (%)	140 (82.4%)	51 (82.3%)	89 (82.4%)
Dyslipidemia, *n* (%)	56 (32.9%)	19 (30.6%)	37 (34.3%)
Previous coronary disease, *n* (%)	47 (27.6%)	20 (32.3%)	27 (25.0%)
Previous stroke or TIA, *n* (%)	31 (18.2%)	8 (12.9%)	23 (21.3%)
Chronic kidney disease, *n* (%)	22 (12.9%)	8 (12.9%)	14 (13.0%)
Duration of diabetes, years, mean ± SD	13.74 (± 10.36)	15.65 (± 10.05)	12.53 (± 10.42)
Metformin, *n* (%)	75 (44.1%)	30 (54.5%)	45 (41.7%)
Admission systolic pressure, mmHg, mean ± SD	154.81 (± 25.53)	159.21 (± 26.32)	152.22 (± 24.82)
Admission diastolic pressure, mmHg, mean ± SD	81.88 (± 15.52)	81.64 (± 15.44)	82 (± 15.63)
Creatinine, mg/dL*, mean ± SD	1.09 (± 0.56)	1.18 (± 0.71)	1.03 (± 0.45)
Admission WBC, 10^3 cells/mm^3*, mean ± SD	9.29 (± 2.87)	8.9 (± 2.89)	9.53 (± 2.8)
Neutrophils, %*, mean ± SD	68.68 (± 10.78)	67.65 (± 10.27)	69.30 (± 11.07)
Lymphocytes, %*, mean ± SD	23.55 (± 9.54)	24.27 (± 8.80)	23.12 (± 9.96)
Platelets × 10^3, cells/mm^3*, mean ± SD	237.73 (± 91.96)	254.42 (± 110.73)	227.85 (± 77.61)
Admission blood glucose, mg/dL*, mean ± SD	185.33 (± 69.52)	187.28 (± 58.05)	184.16 (± 75.80)
Stroke etiology, *n* (%)			
Large artery atherosclerosis	38 (22.4%)	14 (22.6%)	24 (22.2%)
Cardio embolism	59 (34.7%)	15 (24.2%)	44 (40.7%)
Small vessel occlusion	3 (1.8%)	3 (4.8%)	0 (0.0%)
Undetermined	69 (40.6%)	30 (48.4%)	39 (36.1%)
Unknown onset time, *n* (%)	28 (16.5%)	5 (8.2%)	23 (21.3%)
Stroke-to-treatment time, minutes, mean ± SD	251.88 (± 107.26)	211.11 (± 46.74)	279.39 (± 126.47)
Intravenous thrombolysis, *n* (%)	91 (53.6%)	—	29 (26.9%)
rtPA dosage, mg, mean ± SD	61.49 (± 14.47)	62.71 (± 15.21)	58.97 (± 12.69)
Mechanical thrombectomy, *n* (%)	108 (63.5%)	—	—
Duration of MT treatment, minutes, mean ± SD	83.95 (± 53.02)	—	83.95 (± 53.02)
Admission NIHSS, median (IQR)	14 (8–18)	10 (6–15)	14 (10.75–18.25)
Discharge NIHSS, median (IQR)	5 (2–10)	3 (1–7)	6 (3–12)
mRs at 3 months, median (IQR)	4 (2–6)	3 (1–5)	4 (2–6)
3-month mortality, *n* (%)	46 (27.1%)	14 (24.6%)	32 (29.6%)
Intracranial hemorrhage, *n* (%)	59 (34.7%)	22 (35.5%)	37 (34.3%)
Symptomatic hemorrhage, *n* (%)	15 (8.8%)	7 (11.5%)	8 (7.4%)

SD, standard deviation; *TIA*, transitory ischemic attack; *WBC*, white blood cells; *rtPA*, recombinant tissue plasminogen activator; *MT*, mechanical thrombectomy; *NIHSS*, National Institute Of Health Stroke Scale; *mRs*, modified Rankin scale; *IQR*, interquartile range

*Normal value: creatinine (0.5–1.2), WBC (4.5–9.0 × 10^3), neutrophils (60–70%), lymphocytes (20–35%), platelets (150.0–350.0 × 10^3), blood glucose (65–110)

($r = -0.319$; p-value = 0.016); lower admission NIHSS ($r = 0.502$; − value = 0,000) (see Table 3). MA confirmed only admission NIHSS.

The 3-month mortality was associated with older age (84.71 ± 3.93 vs 74.49 ± 9.82; p-value = 0.001), female sex (37.5% vs 15.2%; p-value < 0.053), longer diabetes duration (21.14 ± 10.13 vs 14.27 ± 9.53; p-value = 0.025), no metformin use (40.0% vs 10.7%; p-value < 0.013), higher admission NIHSS (16.5 [8.25–20] vs 8 [5.5–15]; p-value = 0.004) (see Table S2). MA identified older age and higher admission NIHSS as the mortality main predictors.

The ICH was associated with older age (80.73 ± 7.23 vs 74.78 ± 10.11; p-value = 0.018), no metformin use (52.0%

Table 2 Modified Rankin scale (mRs) at 3 months

	Overall		Intravenous thrombolysis		Mechanical thrombectomy	
Qualitative variables	Median (IQR)	*p*-value	Median (IQR)	*p*-value	Median (IQR)	*p*-value
Sex						
Male	3 (1–5.5)	0.147	3 (1–4)	0.060	4 (2–6)	0.928
Female	4 (2–6)		4 (2–6)		4 (2–6)	
Smoke						
Yes	3 (1–4)	0.067	2 (0–3)	0.123	3 (2.25–4)	0.327
No	4 (2–6)		3 (1–6)		4 (2–6)	
Arterial hypertension						
Yes	4 (2–6)	0.531	3 (1–3)	0.469	4 (2–6)	0.996
No	3 (2–5)		3 (1.5–3.5)		5 (2–6)	
Dyslipidemia						
Yes	4 (2–6)	0.291	2 (0–2)	0.087	4 (3.25–6)	0.162
No	4 (2–6)		3.5 (1.25–5.75)		4 (2–6)	
Metformin						
Yes	3 (1–5)	*0.020*	2 (0–4)	*0.004*	3 (2–6)	0.601
No	4 (2–6)		4 (3–6)		4 (2–6)	
Coronary disease						
Yes	4 (2–6)	0.291	4 (1.75–6)	0.226	4 (3–6)	0.545
No	4 (1.75–6)		3 (1–6)		4 (2–6)	
Previous stroke/TIA						
Yes	4 (3–6)	0.118	4 (3.5–5.5)	0.233	4 (3–6)	0.424
No	3 (1–5)		3 (1–5)		4 (2–6)	
Chronic kidney disease						
Yes	4 (2–4.25)	0.779	3.5 (1–4.25)	0.940	4 (2.75–4.25)	0.700
No	4 (2–6)		3 (1–6)		4 (2–6)	
Stroke etiology						
Large artery atherosclerosis	3 (2–5)	0.218	1.5 (0–4)	0.074	4 (3–6)	0.862
Cardio embolism	4 (2–6)		4 (2.5–6)		4 (2–6)	
Small vessel occlusion	1 (0–3)		1 (0.5–2)		—-	
Undetermined	4 (1.25–6)		3 (1–6)		4 (2–6)	
Onset time						
Unknown	3 (2–6)	0.998	2 (1–3)	0.438	3.5 (2–6)	0.924
Known	4 (2–6)		3 (1–5.25)		4 (2–6)	
IVT						
Yes	3 (1–6)	0.081	—-	—-	4 (1–6)	0.689
No	4 (2.25–6)		—-	—-	4 (2.25–6)	
MT						
Yes	4 (2–6)	*0.034*	—-	—-	—-	—-
No	3 (1–5)		—-	—-	—-	—-
Quantitative variables	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value
Age	0.211	*0.009*	0.562	*0.000*	−0.039	0.706
Weight	−0.073	0.423	−0.243	0.072	−0.117	0.336
Diabetes duration	0.086	0.308	0.328	*0.013*	−0.062	0.570
Admission systolic pressure	−0.002	0.982	−0.200	0.140	0.180	0.079
Admission diastolic pressure	−0.057	0.485	−0.230	0.088	0.063	0.543
Creatinine	0.011	0.890	0.065	0.632	−0.037	0.720
Admission WBC	0.034	0.677	0.009	0.945	0.022	0.836
Neutrophils	0.095	0.244	0.159	0.241	0.045	0.667
Lymphocytes	−0.084	0.303	−0.194	0.151	−0.019	0.851

Table 2 (continued)

Qualitative variables	Overall		Intravenous thrombolysis		Mechanical thrombectomy	
	Median (IQR)	*p*-value	Median (IQR)	*p*-value	Median (IQR)	*p*-value
Platelets	−0.038	0.641	0.07	0.957	0.040	0.697
Admission blood glucose	0.202	*0.013*	0.002	0.990	0.297	*0.004*
Stroke-to-treatment time	0.056	0.535	−0.010	0.945	−0.056	0.631
rtPA dosage	−0.123	0.269	−0.226	0.097	0.132	0.504
Duration of MT treatment	0.079	0.464	—-	——	0.045	0.678
Admission NIHSS	0.407	*0.000*	0.538	*0.000*	0.267	*0.008*

Significant *p*-values on univariate analysis are reported in italics

IQR, interquartile range; *TIA*, transitory ischemic attack; *IVT*, intravenous thrombolysis; *MT*, mechanical thrombectomy; *WBC*, white blood cells; *rtPA*, recombinant tissue plasminogen activator; *NIHSS*, National Institutes of Health Stroke Scale score

vs 20.0%; *p*-value < 0.013), higher admission systolic pressure (169.10 ± 32.57 vs 154.03 ± 21.00; *p*-value = 0.032), lower platelet levels (210,714.29 ± 44,976.82 vs 277,375.00 ± 127,498.96; *p*-value = 0.024), stroke etiology (7.1% of large artery atherosclerosis, 60% of cardio embolism, 33.3% of small vessel occlusion, and 36.7% of undetermined subtype; *p*-value < 0.031), unknown onset time (18.2% vs 2.5%; *p*-value = 0.033) (see Table 4). Only age and platelets remained significant on MA.

The only predictor of SICH was metformin use (0.0% vs 20.8%; *p*-value < 0.009) (see Table 5).

Outcome analysis in patients undergoing MT

Analyzing patients undergoing MT, the 3-month mRs score was associated with admission blood glucose ($r = 0.297$; *p*-value = 0.004) and admission NIHSS ($r = 0.267$; *p*-value = 0.008) (see Table 2). This significance persisted on MA.

The discharge NIHSS was associated with IVT (3.5 [1.25–5] vs 7 [4–13]; *p*-value = 0.004; see Fig. 1) and admission NIHSS ($r = 0.437$; *p*-value = 0.000) (see Table 3). MA confirmed these associations.

The 3-month mortality was also linked with admission systolic pressure (160.34 ± 24.91 vs 148.20 ± 25.05; *p*-value = 0.027) and admission glucose levels (215.94 ± 92.34 vs 171.86 ± 63.83; *p*-value = 0.008) (see Table S2). MA confirmed these associations.

The ICH was related only with higher NIHSS (17 [14–20] vs 13 [9–18]; *p*-value = 0.001) (see Table 4).

The predictors of SICH were elevated weight (89.25 ± 11.06 vs 74.06 ± 10.73; *p*-value = 0.008), rtPA dosage (73.33 ± 14.74 vs 56.54 ± 11.18; *p*-value = 0.024), and prolonged MT duration (151.25 ± 105.11 vs 75.55 ± 38.87; *p*-value = 0.001) (see Table 5). MA identified only weight as SICH-independent predictor.

Discussion

Although T2DM is present in one-third of IS, only few studies had evaluated factors determining prognosis among diabetic patients with IS and undergoing RT.

Regarding functional outcome and mortality, we observed an association with admission glycemia in all patients and MT patients but not in the IVT-alone group. Patients undergoing MT, therefore, are probably more influenced by hyperglycemia than IVT patients and this should be considered. In our patients treated only with IVT, mRs score increased according to the glycemia levels but this trend was not significant: hyperglycemia had an influence on functional outcome but it was not a main outcome predictor. Literature data are conflicting about glycemia and functional outcome in diabetics. In IVT patients, two studies did not find an association [12, 13] whereas other three observed it [14–16]. In MT patients, two studies correlated hyperglycemia with a worst functional outcome [17, 18] whereas other two failed to find it [7, 19]. These discrepant responses to hyperglycemia could be due to the difference in chronic glycemic control, diabetic drugs taken, diabetes duration, and other metabolic conditions: further studies should investigate these elements. Another important element of our analysis is that mortality in MT patients was linked to high levels of systolic pressure on the admission. No other studies in literature evaluated pressure influence in diabetic patients treated with MT. A high systolic pressure was associated with a worse functional outcome in general patients undergoing MT in several studies which explained it through reperfusion injury, cerebral edema, and hemorrhagic transformation [20]. Another hypothesis is that hypertension may be a sign of stroke severity rather than a determinant: the organisms increase blood pressure in order to maintain cerebral perfusion [20]. It is interesting to observe that blood pressure was not related with discharge neurological severity, hemorrhagic transformation,

Table 3 NIHSS on discharge

	Overall		Intravenous thrombolysis		Mechanical thrombectomy	
Qualitative variables	Median (IQR)	*p*-value	Median (IQR)	*p*-value	Median (IQR)	*p*-value
Sex						
Male	6 (1–10)	0.342	2 (1–7)	0.303	7 (2.5–10)	0.798
Female	5(2–12)		4 (1.25–8.5)		5.5 (3–12.75)	
Smoke						
Yes	5.5 (1–10)	0.458	1.5 (1–6)	0.428	7 (4.25–10)	0.785
No	5 (2–10)		3 (1–8)		6 (3–11.5)	
Arterial hypertension						
Yes	5 (2–10)	0.632	3 (1–8.5)	0.233	6 (3–10)	0.731
No	5 (1–11)		1 (1–5.5)		8 (3.75–13)	
Dyslipidemia						
Yes	4 (1–10)	0.641	2 (1–7)	0.378	5 (2–10)	0.967
No	6 (2–105)		3.5 (1–9)		6 (3–12)	
Metformin						
Yes	4 (2–7.25)	0.128	2 (1–4.75)	*0.031*	6 (3–8.75)	0.910
No	6 (2–12)		5.5 (1–12)		7 (3–10)	
Coronary disease						
Yes	5 (1.5–10)	0.924	2 (1–6.5)	0.638	6.5 (2.75–11.25)	0.845
No	5 (2–10)		3.5 (1–8.5)		6 (3–10.5)	
Previous stroke/TIA						
Yes	7 (3.25–12.25)	0.227	4 (2.5–8.5)	0.742	7 (4–13.5)	0.372
No	5 (1.5–10)		2(1–7)		6 (3–10)	
Chronic kidney disease						
Yes	5 (3–8)	0.905	2.5 (1–6.25)	0.507	6 (4–10)	0.877
No	5 (1.75–10)		2.5 (1–9)		6 (3–11.5)	
Stroke etiology						
Large artery atherosclerosis	6 (2–10)	0.704	2 (1–4.75)	0.179	6.5 (3–10.75)	0.622
Cardio embolism	5 (2–12)		6 (2–12)		5 (3–9.5)	
Small vessel occlusion	1 (0.5–5)		1 (0.5–5)		—	
Undetermined	5 (1–10)		3 (1–7)		8 (6–12)	
Onset time						
Unknown	6 (2–10)	0.809	4 (0.75–7)	0.514	6.5 (3.5–12.25)	0.913
Known	5 (2–10)		3 (1–9)		6 (3–10)	
IVT						
Yes	3 (1–7)	*0.001*	—-	—-	3.5 (1.25–5)	*0.004*
No	7 (4–13)		—-		7 (4–13)	
MT						
Yes	6 (3–12)	*0.013*	—-	—-	—-	—-
No	3 (1–7)		—-		—-	
Quantitative variables	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value
Age	0.127	0.128	0.332	*0.012*	−0.110	0.306
Weight	−0.091	0.331	−0.106	0.437	−0.096	0.464
Diabetes duration	−0.001	0.994	0.075	0.592	0.026	0.821
Admission systolic pressure	−0.048	0.573	−0.146	0.285	0.075	0.493
Admission diastolic pressure	−0.032	0.707	−0.250	0.063	0.155	0.156
Creatinine	−0.128	0.131	−0.085	0.536	−0.158	0.152
Admission WBC	0.097	0.254	0.017	0.903	0.150	0.173
Neutrophils	0.200	*0.018*	0.330	*0.013*	0.110	0.318
Lymphocytes	−0.199	*0.018*	−0.319	*0.016*	−0.126	0.252

Table 3 (continued)

Qualitative variables	Overall		Intravenous thrombolysis		Mechanical thrombectomy	
	Median (IQR)	*p*-value	Median (IQR)	*p*-value	Median (IQR)	*p*-value
Platelets	−0.062	0.467	−0.140	0.303	0.082	0.460
Admission blood glucose	0.041	0.630	0.007	0.959	0.082	0.462
Stroke-to-treatment time	0.071	0.447	−0.009	0.950	−0.041	0.744
rtPA dosage	−0.101	0.384	−0.075	0.587	−0.263	0.237
Duration of MT treatment	0.200	0.077	—	—	0.197	0.081
Admission NIHSS	0.521	*0.000*	0.502	*0.000*	0.437	*0.000*

Significant *p*-values on univariate analysis are reported in italics

IQR, interquartile range; *TIA*, transitory ischemic attack; *IVT*, intravenous thrombolysis; *MT*, mechanical thrombectomy; *WBC*, white blood cells; *rtPA*, recombinant tissue plasminogen activator; *NIHSS*, National Institutes of Health Stroke Scale score

and functional outcome in our patients: we could also hypothesize that the higher mortality was due to a more severe T2DM rather than stroke damage in itself. T2DM was associated with artery stiffness, autonomic dysfunction, endothelium dysfunction, and impaired nitric oxide (NO) synthesis [21] that can favor an alteration of blood pressure control. IS could be considered a stress test that could induce higher pressure peaks in patients with a more severe neurovascular dysfunction due to T2DM. Conditions such as autonomic dysfunction were indeed associated with an increased mortality in T2DM [22, 23].

Regarding neurological severity on discharge, in all RT group, we observed that MT was associated with higher NIHSS, whereas IVT with lower score probably because most of IVT patients had no large vessel occlusion. It is important to highlight that IVT in patients undergoing MT led to a reduced (almost halved) neurological severity, supporting (with the limits of our small population size) the efficacy of combined treatment in these patients.

Evaluating ICH, platelet levels and age appeared as the main predictors in all RT group and IVT patients which did not influence bleedings in MT. Our study also showed that duration of MT was associated with SICH in all RT but not in MT. We could explain this result as an increased SICH risk in patients undergoing longer MT compared with patients treated only with IVT. In patients undergoing MT, the high weight was the only predictor of SICH. This association was not evaluated in other MT study on T2DM. Regarding hemorrhagic transformation and obesity in general population treated with MT, some studies described no association [24–26], whereas Chen et al. reported a reduction in symptomatic hemorrhage [27]. Another study found no relationship between SICH and metabolic syndrome [28]. In our patients, the combination between T2DM and high weight probably favored an increased vessel fragility that could not be present in obesity alone and in metabolic syndrome, condition in which patients are not always diabetics.

We furthermore found that metformin had a protective role for SICH in IVT patients. Several preclinical study [29–33] and three clinical study showed the positive impact of metformin in ischemic stroke [34–36]. Indeed, metformin plays an anti-oxidant and anti-inflammatory action, favoring the blood–brain barrier integrity and a correct endothelial function [37]. The metformin beneficial effect was not observed in our MT patients, a larger population study is probably necessary in order to find it.

There are several limitations in our study. The small number of patients may have underpowered our analysis. The study in a single institution may have affected the selection of patients but it allowed us to obtain data homogeneity. The retrospective design represents another limit. The glycated hemoglobin would have been a useful data but it was missing in a significant part of patients.

Conclusion

The present study evaluated RT in patients affected by T2DM that constitutes one-third of IS victims and deserve attention in regard to their complexity and fragility. We observed a prognostic role of admission glycemia in MT but not in IVT. The study showed that neurological severity on discharge was reduced in patients undergoing both treatments compared with MT alone. A protective role of metformin for SICH was found in patients treated with IVT, whereas the high weight was a predictor of symptomatic hemorrhage in MT. Our results give several insights in regard to T2DM and stroke RT that need to be confirmed in larger studies, but they represent a starting point in order to ameliorate medical management of these patients.

Table 4 Intracranial hemorrhage (ICH)

	Overall			Intravenous thrombolysis			Mechanical thrombectomy		
	Intracranial hemorrhage			Intracranial hemorrhage			Intracranial hemorrhage		
	Present	Absent	*P*	Present	Absent	*P*	Present	Absent	*P*
Age, years, mean ± SD	78.97 ± 7.90	75.61 ± 8.93	*0.017*	80.73 ± 7.23	74.78 ± 10.11	*0.018*	77.92 ± 8.18	76.10 ± 8.21	0.279
Sex, *n* (%)									
Male	26 (31.7)	56 (68.3)	0.366	10 (30.3)	23 (69.7)	0.363	16 (32.7)	33 (67.3)	0.652
Female	33 (38.4)	53 (61.6)		12 (41.3)	17 (58.7)		21 (36.8)	36 (63.2)	
Weight, kg, mean ± SD	73.93 ± 13.44	73.83 ± 14.02	0.970	70.76 ± 14.25	73.74 ± 17.21	0.500	76.95 ± 21.17	73.91 ± 10.70	0.298
Smoke, *n* (%)									
Yes	4 (16.0)	21 (84.0)	*< 0.031*	1 (10.0)	9 (90.0)	0.066	3 (20.0)	12 (80.0)	0.198
No	54 (38.3)	87 (61.7)		21 (40.4)	31 (59.6)		33 (37.1)	56 (62.9)	
Arterial hypertension, *n* (%)									
Yes	50 (36.0)	89 (64.0)	0.612	19 (37.25)	32 (62.75)	0.530	31 (35.2)	57 (64.8)	0.878
No	9 (31.0)	20 (69.0)		3 (27.3)	8 (72.3)		6 (33.3)	12 (66.7)	
Dyslipidemia, *n* (%)									
Yes	23 (41.8)	32 (58.2)	0.178	8 (42.1)	11 (57.9)	0.469	15 (41.7)	21 (58.3)	0.250
No	35 (31.3)	77 (68.8)		14 (32.6)	29 (67.4)		21 (30.4)	48 (69.6)	
Previous coronary disease, *n* (%)									
Yes	14 (29.8)	33 (70.2)	0.401	7 (35.0%)	13 (65.0%)	0.953	7 (25.9)	20 (74.1)	0.288
No	44 (36.7)	76 (63.3)		15 (37.5)	27 (62.5)		29 (37.2)	49 (62.8)	
Previous stroke/TIA, *n* (%)									
Yes	12 (38.7)	19 (61.3)	0.606	2 (25.0)	6 (75.0)	0.507	10 (43.5)	13 (56.5)	0.293
No	46 (33.8)	90 (66.2)		20 (37.0)	34 (63.0)		26 (31.7)	56 (68.3)	
Chronic kidney disease, *n* (%)									
Yes	5 (22.7)	17 (77.3)	0.204	1 (12.5)	7 (87.5)	0.145	4 (28.6)	10 (71.4)	0.628
No	53 (36.6)	92 (63.4)		21 (38.9)	33 (61.1)		32 (35.2)	59 (64.8)	
Diabetes duration years, mean ± SD	14.92 ± 12.01	13.19 ± 9.38	0.327	15.45 ± 10.03	15.77 ± 10.20	0.908	14.55 ± 13.39	11.65 ± 8.58	0.208
Metformin, *n* (%)									
Yes	22 (29.7)	52 (70.3)	0.168	6 (20.0)	24 (80.0)	*< 0.013*	16 (48.5)	17 (51.5)	0.867
No	30 (40.5)	44 (59.5)		13 (52.0)	12 (48.0)		28 (46.7)	32 (53.3)	
A. systolic pressure, mmHg, mean ± SD	158.34 ± 29.42	153.14 ± 23.16	0.218	169.10 ± 32.57	154.03 ± 21.00	*0.032*	151.89 ± 25.72	152.61 ± 24.49	0.889
A. diastolic pressure, mmHg, mean ± SD	82.41 ± 16.67	81.82 ± 14.95	0.819	85.33 ± 18.53	79.70 ± 13.40	0.178	80.66 ± 15.47	83.09 ± 15.76	0.458
Creatinine, mg/dL, mean ± SD*	1.00 ± 0.33	1.14 ± 0.65	0.144	1.07 ± 0.34	1.24 ± 0.83	0.369	0.95 ± 0.32	1.07 ± 0.51	0.220
A. WBC, cells/mm^3, mean ± SD*	8815.27 ± 2723.41	9497.57 ± 2905.4	0.150	8220.00 ± 1956.36	9208.00 ± 3246.66	0.207	9182.94 ± 3074.49	9670.45 ± 2691.49	0.414

Table 4 (continued)

	Overall			Intravenous thrombolysis			Mechanical thrombectomy		
	Intracranial hemorrhage			Intracranial hemorrhage			Intracranial hemorrhage		
	Present	Absent	*P*	Present	Absent	*P*	Present	Absent	*P*
Neutrophils, %, mean ± SD*	68.95 ± 10.39	69.08 ± 10.23	0.937	68.10 ± 9.92	67.41 ± 10.57	0.807	69.47 ± 10.78	70.08 ± 9.97	0.779
Lymphocytes, %, mean ± SD*	23.47 ± 9.30	23.07 ± 8.86	0.793	24.71 ± 8.85	24.04 ± 8.88	0.780	22.70 ± 9.62	22.50 ± 8.86	0.917
Platelets, %, mean ± SD*	210,574.55 ± 203,000.00	251,046.73 ± 102,239.28	*0.008*	210,714.29 ± 44,976.82	277,375.00 ± 127,498.96	*0.024*	210,488.24 ± 70,967.14	235,328.36 ± 80,692.10	0.132
A. blood glucose, mg/dL, mean ± SD*	188.98 ± 72.67	182.77 ± 68.48	0.594	190.14 ± 55.19	185.78 ± 60.13	0.783	188.26 ± 82.42	180.95 ± 73.47	0.652
Stroke etiology, *n* (%)									
Large artery atherosclerosis	9 (23.7)	29 (76.3)	0.108	1 (7.1)	13 (92.9)	*< 0.031*	8 (33.3)	16 (66.7)	0.337
Cardio embolism	27 (46.6)	31 (53.4)		9 (60.0)	6 (40.0)		18 (41.9)	25 (58.1)	
Small vessel occlusion	1 (33.3)	2 (66.7)		1 (33.3)	2 (66.7)		0 (0.0)	0 (0.0)	
Undetermined	21 (30.9)	47 (69.1)		11 (36.7)	19 (63.3)		10 (26.3)	28 (73.7)	
Onset time, *n* (%)									
Unknown	13 (48.1)	14 (51.9)	0.122	4 (18.2)	18 (81.8)	*0.033*	9 (40.9)	13 (59.1)	0.485
Known	45 (32.6)	93 (67.4)		1 (2.5)	38 (97.5)		27 (32.9)	55 (67.1)	
Stroke-to-treatment time, min, mean ± SD	248.16 ± 105.58	255.12 ± 108.23	0.722	207.71 ± 42.75	215.55 ± 49.13	0.572	276.70 ± 124.73	283.64 ± 127.64	0.816
Intravenous thrombolysis, *n* (%)									
Yes	30 (33.3)	60 (66.7)	0.602	—	—	—	8 (28.6)	20 (71.4)	0.412
No	29 (37.2)	49 (62.8)		—	—		29 (37.2)	49 (62.8)	
rtPA dosage, mg, mean ± SD	63.09 ± 12.38	60.50 ± 15.37	0.437	62.95 ± 12.16	62.60 ± 16.67	0.933	63.44 ± 13.78	56.30 ± 11.63	0.175
Mechanical thrombectomy, *n* (%)									
Yes	37 (34.9)	69 (65.1)	0.940	—	—	—	—	—	—
No	22 (35.5)	40 (64.5)		—	—		—	—	
Duration of MT, min, mean ± SD	93.42 ± 68.17	77.94 ± 42.42	0.174	—	—	—	93.42 ± 68.17	77.94 ± 42.42	0.174
Admission NIHSS, median (IQR)	16 (13–19.5)	12 (8–17)	*0.001*	14.5(7.25–17.75)	9.5 (5.75–15)	0.065	17 (14–20)	13 (9–18)	*0.001*

Significant *p*-values on univariate analysis are reported in italics

P, *p*-value; *SD*, standard deviation; *TIA*, transitory ischemic attack; *A*., admission; *WBC*, white blood cells; *rtPA*, recombinant tissue plasminogen activator; *MT*, mechanical thrombectomy; *NIHSS*, National Institute of Health Stroke Scale; *IQR*, interquartile range

*Normal value: creatinine (0.5–1.2), WBC (4.5–9.0 × 10^3), neutrophils (60–70%), lymphocytes (20–35%), platelets (150.0–350.0 × 10^3), blood glucose (65–110)

Table 5 Symptomatic intracranial hemorrhage (SICH)

	Overall			Intravenous thrombolysis			Mechanical thrombectomy		
	Symptomatic intracranial hemorrhage			Symptomatic intracranial hemorrhage			Symptomatic intracranial hemorrhage		
	Present	Absent	*P*	Present	Absent	*P*	Present	Absent	*P*
Age years, mean ± SD	79.47 ± 9.45	76.59 ± 8.62	0.233	82.71 ± 5.59	76.09 ± 9.83	0.088	76.63 ± 11.49	76.87 ± 7.91	0.937
Sex, *n* (%)									
Male	7 (8.5)	75 (91.5)	0.824	3(9.0)	30(91.0)	0.526	4 (8.2)	45 (91.8)	0.844
Female	8 (9.5)	76 (90.5)		4 (14.3)	24 (85.7)		4 (7.1)	52 (92.9)	
Weight, kg, mean ± SD	76.27 ± 15.72	73.70 ± 13.74	0.559	68.86 ± 13.20	73.27 ± 16.74	0.506	89.25 ± 11.06	74.06 ± 10.73	*0.008*
Smoke, *n* (%)									
Yes	0 (0.0)	25 (100)	0.086	0 (0.0)	10 (100.0)	0.213	0 (0.0)	15 (100)	0.277
No	15 (10.7)	125 (89.3)		7 (13.7)	44 (86.3)		8 (9.0)	81 (91.0)	
Arterial hypertension, *n* (%)									
Yes	13 (9.5)	124 (90.5)	0.658	6 (12.0)	44 (88.0)	0.784	7 (8.0)	80 (92.0)	0.717
No	2 (6.9)	27 (93.1)		1 (9.0)	10 (91.0)		1 (5.6)	17 (94.4)	
Dyslipidemia, *n* (%)									
Yes	6 (11.1)	48 (88.9)	0.517	2 (11.1)	16 (88.9)	0.954	4 (11.1)	32 (88.9)	0.330
No	9 (8.0)	103 (92.0)		5 (11.6)	38 (88.4)		4 (5.8)	65 (94.2)	
Previous coronary disease, *n* (%)									
Yes	6 (13.0)	40 (87.0)	0.265	4 (21.1)	15 (78.9)	0.114	2 (7.4)	25 (92.6)	0.962
No	9 (7.5)	111 (92.5)		3 (7.1)	39 (92.9)		6 (7.7)	72 (92.3)	
Previous stroke/TIA, *n* (%)									
Yes	3 (9.7)	28 (90.3)	0.890	1 (12.5)	7 (87.5)	0.922	2 (8.7)	21 (91.3)	0.826
No	12 (8.9)	123 (91.1)		6 (11.3)	47 (88.7)		6 (7.3)	76 (92.7)	
Chronic kidney disease, *n* (%)									
Yes	0 (0.0)	22 (100)	0.112	0 (0.0)	8 (100.0)	0.275	0 (0.0)	14 (100)	0.248
No	15 (19.4)	129 (89.6)		7 (13.2)	46 (86.8)		8 (8.8)	83 (91.2)	
Diabetes duration years, mean ± SD	13.43 ± 8.61	13.82 ± 10.60	0.894	15.00 ± 9.56	15.75 ± 10.30	0.855	11.86 ± 7.97	12.67 ± 10.66	0.844
Metformin, *n* (%)									
Yes	4 (5.5)	69 (94.5)	0.228	0 (0.0)	30 (100.0)	*< 0.009*	4 (9.3)	39 (90.7)	0.566
No	8 (11.0)	65 (89.0)		5 (20.8)	19 (79.2)		3 (6.12)	46 (93.9)	
A. systolic pressure, mmHg, mean ± SD	155.21 ± 30.17	154.63 ± 24.65	0.933	154.83 ± 35.16	158.57 ± 24.40	0.734	155.50 ± 28.41	152.33 ± 24.64	0.731
A. diastolic pressure, mmHg, mean ± SD	83.21 ± 17.27	81.80 ± 15.90	0.745	84.17 ± 18.00	80.83 ± 14.93	0.613	82.50 ± 17.92	82.37 ± 15.56	0.982
Creatinine, mg/dL, mean ± SD*	0.92 ± 0.23	1.11 ± 0.59	0.242	0.93 ± 0.21	1.22 ± 0.74	0.362	0.91 ± 0.25	1.05 ± 0.47	0.435
A. WBC, cells/mm^3, mean ± SD*	7807.86 ± 2981.04	9405.96 ± 2828.66	*0.046*	7715.00 ± 2239.41	9013.89 ± 2965.03	0.304	7877.50 ± 3592.86	9636.09 ± 2735.75	0.092

Table 5 (continued)

	Overall			Intravenous thrombolysis			Mechanical thrombectomy		
	Symptomatic intracranial hemorrhage			Symptomatic intracranial hemorrhage			Symptomatic intracranial hemorrhage		
	Present	Absent	*P*	Present	Absent	*P*	Present	Absent	*P*
Neutrophils, %, mean ± SD*	69.89 ± 11.51	69.01 ± 10.22	0.763	70.17 ± 13.85	67.44 ± 10.01	0.545	69.68 ± 10.44	69.93 ± 10.28	0.946
Lymphocytes, %, mean ± SD*	23.31 ± 10.53	23.14 ± 8.19	0.948	23.17 ± 13.18	24.34 ± 8.43	0.761	23.41 ± 9.05	22.43 ± 9.15	0.772
Platelets, %, mean ± SD*	207,285.71 ± 56,488.84	240,449.32 ± 95,335.28	0.203	196,500.00 ± 51,024.50	261,537.04 ± 114,794.77	0.178	215,375.00 ± 62,385.75	228,071.74 ± 79,927.48	0.663
A. blood glucose, mg/dL, mean ± SD*	204.00 ± 62.61	184.16 ± 70.21	0.310	211.83 ± 43.97	186.02 ± 58.69	0.302	198.13 ± 76.20	183.05 ± 76.52	0.594
Stroke etiology, *n* (%)									
Large artery atherosclerosis	1 (2.6)	37 (97.4)	*< 0.051*	0 (0.00)	14 (100.0)	0.227	1 (4.2)	23 (95.8)	0.122
Cardio embolism	9 (15.5)	49 (84.5)		3 (20.0)	12 (80.0)		6 (14.0)	37 (86.0)	
Small vessel occlusion	1 (33.3)	2 (66.7)		1 (33.3)	2 (66.7)		0 (0.0)	0 (0.0)	
Undetermined	4 (6.0)	63 (94.)		3 (10.3)	26 (89.7)		1 (2.6)	37 (97.4)	
Onset time, *n* (%)									
Unknown	2 (7.4)	25 (92.6)	0.724	0 (0.0)	5 (100.0)	0.396	2 (9.1)	20 (90.9)	0.794
Known	13 (9.6)	123 (90.4)		7 (13.2)	48 (86.8)		6 (7.4)	75 (92.6)	
Stroke treatment time, min, mean ± SD	212.69 ± 89.85	258.64 ± 108.24	0.142	185.00 ± 40.62	217.65 ± 46.81	0.109	248.33 ± 121.76	285.75 ± 126.59	0.487
Intravenous thrombolysis, *n* (%)									
Yes	10 (11.2)	79 (88.8)	0.288	—	—	—	3 (10.7)	25 (89.3)	0.471
No	5 (6.5)	72 (93.5)		—	—		5 (6.5)	72 (93.5)	
rtPA dosage, mg, mean ± SD	65.56 ± 13.79	60.81 ± 14.64	0.357	61.67 ± 12.75	62.83 ± 15.70	0.862	73.33 ± 14.74	56.54 ± 11.18	*0.024*
Mechanical thrombectomy, *n* (%)									
Yes	8 (7.6)	97 (92.4)	0.403	—	—	—	—	—	—
No	7 (11.5)	54 (88.5)		—	—		—	—	
Duration of MT, min, mean ± SD	151.25 ± 105.11	75.55 ± 38.87	*0.001*	—	—	—	151.25 ± 105.11	75.55 ± 38.87	*0.001*
Admission NIHSS, median (IQR)	17 (11–19)	13 (8–17.5)	0.152	15 (4.5–19.5)	10 (6.25–15)	0.328	17 (16.75–18.5)	14 (10–18)	0.156

Significant *p*-values on univariate analysis are reported in italics

P, *p*-value; *SD*, standard deviation; *TIA*, transitory ischemic attack; *A*., admission; *WBC*, white blood cells; *rtPA*, recombinant tissue plasminogen activator; *MT*, mechanical thrombectomy; *NIHSS*, National Institute of Health Stroke Scale; *IQR*, interquartile range

*Normal value: creatinine (0.5–1.2), WBC (4.5–9.0 × 10^3), neutrophils (60–70%), lymphocytes (20–35%), platelets (150.0–350.0 × 10^3), blood glucose (65–110)

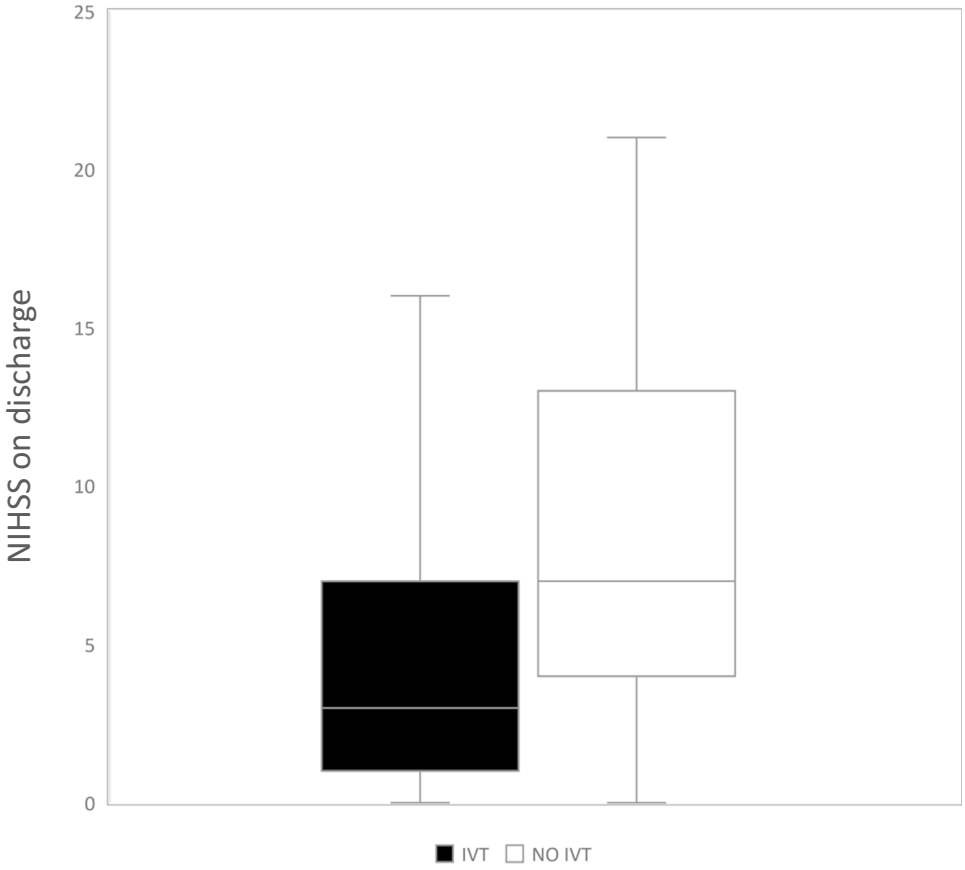

Fig. 1 NIHSS on discharge in MT patients according to IVT treatment

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10072-022-05935-x.

Acknowledgements We would like to thank L.R., C.A., and C.M.L. for the strong support in these years; F.F. for the opportunity; A.G., M.A., and R.S. for the long and strong partnership; N.G., Z.V., and C.A. for the partnership and the support in these unforgettable years; C.A. also for the method, the advices, the spark, and the research interest in common; F.I., V.C., and G.F. for the partnership, the advices, and for being an example; C.D., D.J., G.A., and F.G. for the partnership and their limitless kindness; C.M. for believing in us from the beginning; D.C. for being a wonderful person; M.R. for the motivation; and all members of our neurology department in particular the physicians in training.

Author contribution C.C.T. contributed to the study design; C.C.T., C.M., P.A., L.M., V.S.L., F.M.C., G.F., and D.C. performed the data collection; T.G. performed the statistical analysis; C.M., G.R., L.P., C.C., T.A., L.M., G.F., and M.R.F. supervised the research; C.C.T., F.G., M.R.F., and R.G. wrote the article.

Data availability Derived data supporting the findings of this study are available from the corresponding author on request.

Declarations

Ethical approval The research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The study protocol has been approved by the research institute's committee on human research.

Consent to participate and for publication All the patients have given their written informed consent.

Conflict of interest The authors declare no competing interests.

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