

Post-stroke infection in acute ischemic stroke patients treated with mechanical thrombectomy does not affect long-term outcome

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Abstract

Introduction: The impact of an infection that requires antibiotic treatment (IRAT) after an acute ischemic stroke (AIS) treated with mechanical thrombectomy (MT) remains unclear.

Aim: Here, we studied the prevalence and the profile of IRAT in patients with AIS treated with MT, aiming to identify predictive factors and prognostic implications at 90 days after stroke.

Material and methods: We analyzed parameters available within 24 h after AIS including demographics, risk factors, National Institutes of Health Stroke Scale (NIHSS) upon admission and 24 h later, hemorrhagic transformation (HT) on computed tomography, and several clinical and biochemical markers. The outcome measures were the modified Rankin Scale (mRS) 0-2 and 90 days post-stroke mortality.

Results: We included 291 patients; in 184 (63.2%) patients MT was preceded by intravenous thrombolysis (IVT), and 83 (28.5%) patients developed IRAT. Multivariate analysis showed that male sex and hemorrhagic transformation on CT taken 24 h after stroke increased the risk of IRAT. We found that younger age, male sex, lower delta NIHSS, shorter time from stroke onset to groin puncture, better recanalization and a lack of hemorrhagic transformation on CT taken 24 h after stroke favorably affected outcome at day 90. Multivariate analysis showed that older age, higher delta NIHSS, unknown stroke etiology and lack of treatment with IVT were independent predictors of death up to day 90. Infection that required antibiotic treatment did not enter in the models for the studied outcome measures.

Conclusions: In AIS patients treated with MT, IRAT is not an independent factor that affects favorable outcome or mortality 90 days after stroke.

Key words: mortality, acute ischemic stroke, infections, antibiotic therapy, mechanical thrombectomy, long-term outcome.

Summary

To the best of our knowledge, no study has yet evaluated the prevalence and the profile of infection that requires antibiotic treatment (IRAT) or parameters affecting the risk of IRAT and its prognostic significance in patients with acute ischemic stroke (AIS) treated with mechanical thrombectomy (MT). We included 291 AIS patients and 83 (28.5%) developed IRAT. We found that IRAT was not an independent factor affecting favorable outcome or mortality 90 days after stroke; however, we confirmed the prognostic significance of commonly accepted parameters such as age, sex, neurological deficit assessed by NIHSS score, time from stroke onset to groin puncture, recanalization rate as measured by the Thrombolysis in Cerebral Infarction (TICI) score, and hemorrhagic transformation of ischemic lesion on CT after the procedure.

Introduction

Ischemic stroke is an important cause of morbidity and mortality worldwide with a considerable social and

economic burden [1]. Since 2015, mechanical thrombectomy (MT) has been an approved treatment option for acute ischemic stroke (AIS) patients with their acute clot located in a large brain artery and who do not respond to

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intravenous thrombolysis (IVT) or who are outside their therapeutic window for IVT or for whom IVT is contraindicated [2]. MT markedly improves functional outcome of AIS compared to other treatment options [3]. Time from stroke onset to groin puncture is an important modifiable parameter affecting prognosis of patients treated with MT [4]. The question arises whether the efficacy of MT can be improved even more by identifying other modifiable factors that affect outcome.

Infection that requires antibiotic treatment (IRAT) is a common medical complication in AIS patients [5]. Several parameters that increase the risk of infection in AIS patients have been identified including age, sex, several comorbidities, cognitive alterations, preadmission dependency, speech problems, dysphagia, stroke severity, etc. [6–11]. Infection in AIS correlates significantly with longer in-hospital stay, higher medical costs [12, 13], and poor prognosis and mortality [14, 15].

To the best of our knowledge, no study has yet evaluated the prevalence and the profile of IRAT or parameters affecting the risk of IRAT and its prognostic significance in patients treated with MT. Knowledge about this important clinical aspect of AIS would be helpful in establishing standards of prevention.

Aim

We evaluated the prevalence and the profile of IRAT in AIS patients treated with MT. We also studied whether IRAT affected long-term favorable outcome defined by the modified Rankin Scale (mRS) score from 0 to 2 or mortality at day 90.

Material and methods

We retrospectively analyzed data prospectively collected from 291 patients with AIS who underwent MT at the Comprehensive Stroke Center in Krakow in the period from January 2013 to August 2019. The study was approved by the Jagiellonian University Ethical Committee (KBET 54/B/2007). We received written informed consent from all participants. All procedures were performed in accordance with the Declaration of Helsinki [16]. Stroke diagnosis was consistent with the WHO definition [17]. Details of patients' check-ups have been described previously [4].

In the present study we examined the following parameters: (1) demographics including age and sex; (2) stroke risk factors including hypertension, diabetes mellitus, ischemic heart disease, atrial fibrillation (AF), smoking status (smokers were those who were smoking while they were recruited into the study or those who had smoked in the past); (3) clinical data such as the TICl scale after the procedure [18], time-lapse from stroke onset to groin puncture (SO-GP), and stroke severity on admission and 24 h later according to the National Institutes of Health Stroke Scale (NIHSS) [19]. Del-

ta NIHSS was defined as the difference between NIHSS score tested 24 h after MT and upon hospital admission; low scores reflect improvement, and high scores indicate deterioration. We also measured post-treatment hemorrhagic transformation on computed tomography (CT) taken 24 h after stroke (patients were categorized as with or without bleeding), body temperature on admission, and stroke etiology according to the Trial of Org10172 in Acute Stroke Treatment (TOAST) criteria [20]. For this project the participants were classified as those with unknown etiology and those with a defined etiology (large vessel disease stroke, small vessel disease stroke, cardio-embolic stroke or stroke due to rare etiology).

We studied the occurrence of infection that required antibiotic treatment during hospitalization (IRAT). Diagnosis of infection was based on clinical symptoms, e.g., fever, laboratory tests, microbiological assays, and chest X-rays. We considered the following types of infection: pneumonia, urinary tract infection, thrombophlebitis, and wound infection. We distinguished two types of pneumonia: community acquired pneumonia (CAP) and nosocomial pneumonia. Routinely in our hospital, first line treatment for patients with CAP is ceftriaxone and for patients with nosocomial pneumonia is ceftriaxone and levofloxacin. If these antibiotics are not effective we modify the treatment according to the antibiogram. For patients with urinary tract infection the first-line treatment is cefuroxime. If this antibiotic is not effective we modify the treatment according to the antibiogram. Fasting blood samples on the first morning after admission were also tested for white blood cell count (WBC), hemoglobin levels, glucose levels, creatinine, TSH, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides. We also studied treatment with IVT prior to MT and the following treatments before AIS: antiplatelets, anticoagulants, and statins.

The outcome measures were the modified Rankin Scale [21] (mRS) 0-2 and mortality 90 days after stroke.

Statistical analysis

Clinical characteristics and outcomes between the groups were compared using unpaired Student's *t*-test or the χ^2 test where appropriate. To identify potential independent predictors of outcome, variables with *p*-values < 0.05 in the univariate regression analyses for IRAT, favorable outcome or death were subsequently included in multivariate regression analyses.

All statistical calculations were performed by Statistica software version 12.5 (TIBCO software INC). *P*-values below 0.05 were considered statistically significant.

Results

MT was performed in 291 patients. Infection that required antibiotics during hospitalization was seen in

83 (28.5%) patients: 51 (17.5%) patients developed pneumonia, 28 (9.6%) developed urinary tract infections, 1 (0.3%) patient developed wound infection, 1 (0.3%) patient developed sepsis, and 2 (0.7%) patients developed an infection of unclear origin. Eleven (21.6%) patients developed CAP, and 40 (78.4%) developed nosocomial pulmonary infection. Ten (19.6%) patients required an antibiogram, since they did not respond to first-line antibiotics. The cultures revealed the following pathogens: *Staphylococcus aureus* MSSA (3); *Staphylococcus aureus* MRSA (2); *Klebsiella pneumoniae* ESBL (+) (2); *Klebsiella pneumoniae* (1); *Escherichia coli* (1); *Enterobacter cloacae* (1). In each case antibiotics were used according to the antibiogram. Nineteen out of 28 patients with urinary tract infection (67, 9%) responded to the first-line antibiotic. In the remaining 9 patients the cultures revealed the following pathogens: *Escherichia coli* (5); *Escherichia coli* ESBL (+) (1); *Proteus mirabilis* (1); *Enterococcus faecalis* (1); *Staphylococcus aureus* MSSA (1). In each case antibiotics were used according to the antibiogram. The blood culture of the patient with sepsis revealed *Staphylococcus aureus* and the patient was treated according to the antibiogram. Cultures from urine, blood and from bronchoalveolar lavage from the 2 patients with infection of unclear origin did not show any pathogens. Patients were treated with ceftriaxone and levofloxacin.

Patients who developed IRAT were older and more often were men. Univariate analysis showed that several features correlated with IRAT: diabetes mellitus, ischemic heart disease, AF, higher delta NIHSS, hemorrhagic transformation on CT taken 24 h after stroke, antiplatelet treatment, statin use before stroke, and higher glucose levels on the next day after admission (Table I). Multivariate analysis showed that male sex and hemorrhagic transformation on CT taken 24 h after stroke increase the risk of IRAT (Table II).

Here, 154 (52.9%) patients had favorable outcomes at day 90. Univariate analysis showed that patients with a favorable outcome were significantly younger, more often male, and with lower rates of diabetes mellitus. They had a significantly better recanalization rate, shorter time from stroke onset to groin puncture, and lower delta NIHSS than those with a poor outcome. Patients with favorable outcomes were less likely to have a hemorrhagic transformation on CT, more likely to be treated with IVT and less likely to develop IRAT. They also had higher hemoglobin levels and lower glucose levels the next morning (Table I).

Multivariate analysis showed that younger age, male sex, lower delta NIHSS, better recanalization as graded by the TIC1 score, shorter time from stroke onset to groin puncture, and lack of hemorrhagic transformation on CT taken 24 h after stroke favorably affected outcomes at day 90. Infection that required antibiotic treatment did not affect this outcome (Table II).

There were 63 (21.6%) deaths within 90 days. Patients who died more often were diagnosed with stroke of unknown origin while those who survived more often had a diagnosis of large vessel disease stroke (Table I). Univariate analysis showed that patients who died were older. Compared to their surviving counterparts, patients who died had worse recanalization as graded by TIC1 score, higher delta NIHSS, more frequently presented with hemorrhagic transformation on CT taken within 24 h after treatment and more often had stroke of unknown etiology. They less frequently had intravenous thrombolysis and they more often used statins before stroke and were more likely to develop IRAT. They had lower hemoglobin levels, higher WBC counts, and higher glucose levels the next morning after admission. Multivariate analysis showed that older age, higher delta NIHSS, unknown stroke etiology and lack of treatment with IVT were independent predictors of death up to day 90.

Discussion

Many studies in patients with AIS, irrespectively of their acute treatment method [14, 15, 22–24], focus on analyzing the prevalence, the profile, and the prognostic significance of infection. Infection in AIS is an important aspect of stroke clinics, i.e., with respect to complications, lengths of hospital stay, or prognosis; however, clinical trials have shown that preventive antibiotic therapy did not improve functional outcome in relatively unselected AIS patients [25, 26].

To the best of our knowledge, the clinical characteristics of infection in AIS patients treated with MT have not yet been studied. MT is clearly better than other AIS therapies with a number needed to treat (NNT) less than three for improved functional outcome [3]; thus, the prognosis in AIS treated with MT may be determined by a different set of factors relative to other subgroups of AIS patients. For comparison, the NNT in AIS patients treated with IVT within 90 min after stroke onset is 5; this value is nine for those treated 3.0 to 4.5 h after stroke [27].

The prevalence of infection in AIS is high, ranging from 5% to 65% depending on the study population and the definition of infection [28]. It was 28.5% in our study. The most common infection in AIS is pneumonia – a recent systematic review reported a prevalence of 14.3% [29]. The prevalence of pneumonia is slightly higher in our study (17.5%).

From the pathophysiologic point of view the high risk of infection in AIS patients is thought to be related to stroke-induced immunodepression syndrome (SIDS), which is responsible for a long-lasting alteration of the lymphocyte profile and disturbances in cytokine production [30, 31]. Additionally, the key factor specifically increasing the risk of pneumonia in AIS is dysphagia, causing oropharyngeal aspiration [32].

Table 1. Demographics, stroke characteristics, treatment and biochemical markers in patients treated with mechanical thrombectomy without and with infection that requires antibiotic treatment (IRAT) during hospitalization. Two comparisons in patients in modified Rankin Scale (mRS) at day 90 after index hospitalization: (1) 0–2 vs mRS: 3–6 and (2) mRS: 0–5 vs mRS: 6 (death)

Parameter	Index hospitalization			90 days after index hospitalization					
	No IRAT N = 208	IRAT N = 83	P-value	mRS: 0–2 N = 154	mRS: 3–6 N = 137	P-value	mRS: 0–5 (alive) N = 228	mRS = 6 (death) N = 63	P-value
Demographics:									
Age [years], mean ± SD	65.3 ±14.8	69.8 ±12.9	0.016	62.9 ±14.7	70.7 ±12.9	0.000002	65.4 ±14.7	71.1 ±12.4	0.0051
Sex (female), n (%)	110 (52.9)	33 (39.8)	0.043	61 (39.6)	82 (59.9)	0.00057	108 (47.4)	35 (55.6)	0.25
Stroke risk factors, n (%):									
Hypertension	143 (68.8)	66 (79.5)	0.065	106 (68.8)	103 (75.2)	0.39	158 (69.3)	51 (81)	0.069
Diabetes mellitus	49 (23.6)	31 (37.3)	0.018	30 (19.5)	50 (36.5)	0.0012	58 (25.4)	22 (34.9)	0.14
Ischemic heart disease	49 (23.6)	34 (41.0)	0.003	42 (27.3)	41 (29.9)	0.62	60 (26.3)	23 (36.5)	0.11
Atrial fibrillation	75 (36.1)	41 (49.4)	0.036	55 (35.7)	61 (44.5)	0.13	87 (38.2)	29 (46)	0.26
Smoking	40 (19.3)	10 (12)	0.14	31 (20.1)	19 (13.9)	0.16	44 (19.3)	6 (9.5)	0.069
Clinical parameters:									
TICI, n (%) (post-thrombectomy TICI: 0-2a)	51 (24.5)	27 (32.5)	0.14	20 (13)	58 (42.3)	< 0.00001	52 (22.4)	27 (42.9)	0.0012
Time [h], mean ± SD	4.53 ±1.84	4.35 ±1.44	0.44	4.3 ±1.7	4.7 ±1.8	0.02	4.4 ±1.81	4.54 ±1.44	0.75
NIHSS on admission, mean ± SD	15.1 ±6.6	16.3 ±5.1	0.12	14.5 ±6.5	16.6 ±5.6	0.0027	15.1 ±6.1	16.9 ±6.4	0.04
NIHSS 24 h after admission, mean ± SD	11 ±9.2	15.3 ±9	0.00038	7 ±6.4	18.2 ±8.5	< 0.00001	9.5 ±7.1	22.1 ±9.6	< 0.00001
Delta NIHSS, mean ± SD	-4.1 ±9	-1 ±9.8	0.012	-7.4 ±7.6	1.5 ±8.8	< 0.00001	-5.5 ±7.4	5.2 ±10.6	< 0.000001
Hemorrhagic transformation of ischemic lesion on CT, n (%)	78 (37.5)	47 (56.6)	0.0029	48 (31.2)	77 (56.2)	< 0.000017	88 (38.6)	37 (58.7)	0.0043
Body temperature on admission, mean ± SD	36.4 ±0.38	36.4 ±0.46	0.99	36.4 ±0.4	36.4 ±0.4	0.82	36.4 ±0.4	36.3 ±0.3	0.59
Infection during hospitalization	X	X	X	32 (20.8)	51 (37.2)	0.0019	56 (24.6)	27 (42.9)	0.0044

Table 1. Cont.

Time frame	Index hospitalization			90 days after index hospitalization					
	No IRAT N = 208	IRAT N = 83	P-value	mRS: 0-2 N = 154	mRS: 3-6 N = 137	P-value	mRS: 0-5 (alive) N = 228	mRS = 6 (death) N = 63	P-value
Stroke etiology, n (%):									
Large vessel disease	26 (12.5)	5 (6)	0.97	23 (14.9)	8 (5.9)	0.3539	30 (13.2)	1 (1.6)	0.022
Small vessel disease	0	0		0	0		0	0	
Cardioembolic stroke	88 (42.3)	47 (56.6)		72 (46.7)	63 (46.0)		106 (46.5)	29 (46.0)	
Rare etiology	41 (19.1)	10 (12)		23 (14.9)	28 (20.4)		41 (18)	10 (15.9)	
Unknown etiology	53 (25.5)	21 (25.3)		36 (23.4)	38 (27.7)		51 (22.4)	23 (36.5)	
Treatment, n (%):									
Intravenous thrombolysis	132 (63.4)	52 (62.7)	0.9	107 (69.5)	77 (56.2)	0.019	153 (67.1)	31 (49.2)	0.0091
Anticoagulants before AIS	22 (10.6)	15 (18.1)	0.083	19 (12.3)	18 (13.2)	0.84	27 (11.8)	10 (15.8)	0.4
Antiplatelet treatment before AIS	38 (18.3)	25 (30.1)	0.027	32 (20.8)	31 (22/6)	0.7	49 (21.5)	14 (22.2)	0.9
Statins before AIS	29 (13.9)	21 (25.3)	0.02	23 (14.9)	27 (19.7)	0.28	33 (14.5)	17 (27)	0.02
Fasting biochemical parameters tested on the next morning after admission:									
WBC count, mean ± SD [μl]	9398.4 ±3168.4	10249.1 ±3756	0.054	9311.8 ±3437.3	10020.2 ±3244.3	0.076	9390.4 ±3366.6	10557 ±3206.7	0.016
Hemoglobin, mean ± SD [g/dl],	12.7 ±2	12.4 ±2.46	0.31	13.1 ±1.9	12.1 ±2.4	0.00017	12.8 ±2.0	12.0 ±2.5	0.01
Glucose level (mmol/l), mean ± SD	6.4 ±2	7.3 ±2.7	0.0015	6.1 ±1.7	7.5 ±4.1	0.000053	6.4 ±3.1	7.9 ±3.0	0.00091
TSH, mean ± SD [μIU/ml]	1.89 ±2.81	1.62 ±1.91	0.45	1.9 ±2.6	1.7 ±2.6	0.75	1.93 ±2.81	1.23 ±1.03	0.098
LDL cholesterol, mean ± SD [mmol/l]	2.52 ±1.03	2.26 ±1.03	0.063	2.5 ±1	2.4 ±1	0.22	2.5 ±1	2.2 ±1	0.11
HDL cholesterol, mean ± SD [mmol/l]	1.25 ±0.47	1.35 ±0.73	0.17	1.3 ±0.7	1.3 ±0.7	0.88	1.3 ±0.6	1.2 ±0.4	0.11
Triglycerides, mean ± SD [mmol/l]	1.34 ±0.78	1.28 ±0.77	0.56	1.4 ±0.9	1.2 ±0.7	0.074	1.3 ±0.8	1.2 ±0.5	0.25
Creatinine (40–80 μmol/l), n (%)	68 (32.7)	26 (31.3)	0.82	53 (34.4)	41 (29.2)	0.41	74 (32.5)	20 (31.7)	0.91

AIS – acute ischemic stroke, CT – computed tomography, HDL – high-density lipoprotein, IRAT – infection that requires antibiotic treatment, LDL – low-density lipoprotein, mRS – modified Rankin Scale, NIHSS – National Institutes of Health Stroke Scale, SD – standard deviation, TIC1 – Thrombolysis in Cerebral Infarction, WBC – white blood cells.

Table II. Multivariate logistic regression models showing: (1) factors affecting risk of infection that requires antibiotic treatment, (2) factors affecting favorable outcome (mRS: 0–2) at day 90 and (3) factors affecting mortality (mRS: 6) at day 90

Factors affecting risk of infection that requires antibiotic treatment	OR	95% CI	P-value
Demographics:			
Age [years]	1.02	0.995–1.05	0.1
Sex (female)	0.39	0.21–0.72	0.0026
Stroke risk factor:			
Diabetes mellitus	1.01	0.52–1.97	0.97
Ischemic heart disease	1.47	0.79–2.74	0.22
Atrial fibrillation	1.42	0.76–2.63	0.27
Clinical parameters:			
Delta NIHSS	1.02	0.99–1.05	0.18
Hemorrhagic transformation of ischemic lesion on CT 24 h after admission	1.84	1.05–3.25	0.034
Treatment:			
Antiplatelet treatment before AIS	1.5	0.68–3.31	0.31
Statins before AIS	1.16	0.5–2.73	0.72
Biochemical parameters:			
Fasting glucose level on the next day after admission 24 h [mmol/l]	1.12	0.98–1.27	0.094
Factors affecting favorable outcome at day 90 (mRS: 0–2)	OR	95% CI	P-value
Demographics:			
Age [years]	0.95	0.93–0.98	0.00048
Sex (female)	0.46	0.23–0.93	0.031
Stroke risk factors:			
Diabetes mellitus	0.60	0.28–1.29	0.19
Clinical parameters:			
Delta NIHSS	0.87	0.82–0.91	0.0000022
Post-thrombectomy TICl score: 0, 1, 2a	0.27	0.12–0.58	0.00086
Time from stroke onset to groin puncture [h]	0.78	0.64–0.97	0.02
Infection that requires antibiotic treatment	0.72	0.34–1.49	0.37
Hemorrhagic transformation of ischemic lesion on CT 24 h after admission	0.47	0.24–0.9	0.023
Treatment:			
Intravenous thrombolysis	1.33	0.68–2.62	0.4
Biochemical parameters:			
Fasting glucose level on the next day after admission 24 h [mmol/l]	0.93	0.8–1.09	0.39
Hemoglobin [g/dl]	1.14	0.97–1.34	0.11
Factors affecting risk of death at day 90	OR	95% CI	P-value
Demographics:			
Age [years]	1.04	1.009–1.07	0.010
Sex (female)	0.65	0.30–1.42	0.27

Table II. Cont.

Factors affecting risk of death at day 90	OR	95% CI	P-value
Clinical parameters:			
Post-thrombectomy TICl score: 0, 1, 2a	1.18	0.30–1.42	0.68
Delta NIHSS	1.17	1.10–1.24	0.00000019
Hemorrhagic transformation on CT 24 h after admission	2.00	0.96–4.20	0.062
Infection that requires antibiotic treatment	1.21	0.56–2.63	0.63
Stroke etiology:			
Unknown etiology of stroke	3.55	1.55–8.15	0.0027
Treatment:			
Intravenous thrombolysis	0.41	0.19–0.88	0.0021
Biochemical parameters:			
WBC count [μ l]	1.10	0.99–1.23	0.065
Fasting glucose level on the next day after admission 24 h [mmol/l]	1.05	0.96–1.15	0.31

AIS – acute ischemic stroke, CI – confidence interval, CT – computed tomography, mRS – modified Rankin Scale, NIHSS – National Institutes of Health Stroke Scale, OR – odds ratio, TICl – Thrombolysis in Cerebral Infarction, WBC – white blood cells.

The most commonly mentioned predictors of infection in AIS patients, irrespectively of their acute treatment status, are older age, sex for different type of infection, stroke severity, bedridden state, dysphagia or reduced bulbar reflexes, chronic obstructive pulmonary disease, diabetes mellitus, or specific invasive maneuvers (feeding tube placement, urinary catheterization, etc.) [6, 7, 24]. The profile of factors affecting the risk of pneumonia in an unselected group of AIS patients or patients treated solely with IVT is similar to those mentioned above [8–11, 22, 23].

Many previous studies in AIS patients regardless of their acute treatment status showed that infection leads to worse outcomes. The occurrence of any post-stroke infection is associated with the odds ratio for a poor functional outcome that varied from 0.9 to 4.4; the odds ratio for mortality varies from 1.5 to 6.0. Regarding pneumonia, the evidence for functional outcomes is limited, and the odds ratio varies from 1.7 to 52. For mortality, the odds ratio varies from 2.1 to 3.0 [28].

In the present study univariate analysis confirmed that infection was less frequent in patients with better prognosis and significantly more common in those who died. Interestingly, infection did not enter the logistic regression models for either prognostic outcome (favorable outcome or death at day 90). In our study, however, we confirmed the prognostic significance of several factors previously shown to be related to long-term prognosis in patients treated with MT, such as age [33], sex [34], time from stroke onset to groin puncture [35], recanalization after MT [33, 36], and hemorrhagic transformation on CT after the procedure [33]. We also observed for the first time that lower delta NIHSS – which in our study reflects the neurological improvement after the procedure – was

an independent factor affecting favorable outcome at day 90. A higher delta NIHSS reflects clinical deterioration after the procedure in our study, and this score was an independent risk factor of death at day 90. Our findings showing the correlation of AIS etiology and the lack of IVT treatment before MT with 90 day mortality needs confirmation in different populations.

Our study has some limitations. First, this was a retrospective and single-center study including only patients who could give signed consent. This study was based on data acquired in a single hospital, and thus the results may be not comparable with patients collected in a multicenter prospective study. Further prospective studies are needed to validate our findings. Unfortunately, we did not collect C reactive protein levels from the first 67 cases included in our study; thus, this parameter was not included in the present analysis. We are aware that this is an important factor affecting stroke outcome [37]. Finally, we did not systematically collect information about dysphagia or intubation during the procedure; both are important factors related to the risk of pneumonia.

Conclusions

In the present study infections are a common finding in patients with AIS treated with MT, and in contrast to studies on unselected AIS patients or patients treated with IVT, the presence of IRAT did not affect the studied long-term outcome measures.

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Conflict of interest

The authors declare no conflict of interest.

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