Original paper

Long-term outcomes of mechanical thrombectomy in acute ischaemic stroke patients with concomitant malignancy

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A b s t r a c t

Introduction: Patients with cancer (CP) need a different approach to acute ischaemic stroke (AIS) treatment as intravenous thrombolysis (IVT) may be contraindicated. Mechanical thrombectomy (MT) is a treatment of choice for otherwise eligible patients, although the literature on its long-term outcomes in CP is limited.

Aim: Assessing outcomes of MT-treated AIS patients with concomitant malignancy in a year-long follow-up.

Material and methods: The study included 593 MT-treated AIS patients admitted in 2019–2021. The group was divided into CP (defined as a diagnosis of malignancy and undergoing/qualified for cancer treatment within previous 5 years) and a control group. The profile of cardiovascular risk factors, stroke severity and discharge, 90-day and 365-day outcomes were compared between the groups.

Results: CP and controls had a similar profile of cardiovascular risk factors and comparable stroke severity. CP were less frequently treated with IVT (25.7% vs. 59.1%, $p < 0.001$). There were no differences between the groups in the successful reperfusion rate and occurrence of haemorrhagic complications. Discharge and 90-day outcomes were similar. CP had higher 365-day mortality (48.6% vs. 29.9%, $p = 0.024$) but the percentage of patients achieving good functional outcome in a year-long observation was comparable.

Conclusions: Treatment with MT seems beneficial for AIS patients with concomitant malignancy both in short- and long-term observation.

Key words: acute ischaemic stroke, cancer, cancer-related stroke, mechanical thrombectomy, endovascular stroke treatment.

S u m m a r y

Among 593 patients with acute ischaemic stroke treated with mechanical thrombectomy, 35 patients with concomitant cancer disease (CP) had similar in-hospital and 90-day outcomes in terms of mortality and good functional status rates. The 365-day mortality was higher in CP, but the percentage of patients achieving good functional outcome in a year-long observation was comparable between the groups.

Introduction

Acute ischemic stroke (AIS) is a life-threatening emergency and one of the leading causes of death and disability worldwide, with its global burden escalating over the recent years [1]. Systemic cancer disease is shown to increase the risk of AIS [2]. Numerous types of cancer have been associated with AIS through different mechanisms, including a direct effect of the tumour (such as vessel invasion), hypercoagulopathy, infections and cancer treatment complications [3]. Among patients

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with cancer (CP), cerebrovascular diseases are a common complication, occurring in about 15% [4]. Cancer as a comorbidity is found in about 10% of patients hospitalised due to AIS in the United States [5] and the prevalence of cancer is higher among patients with AIS than in the general population [6]. Therefore, concomitance of stroke and cancer represents an important public health issue, as well as a relatively common problem in everyday clinical practice.

At the same time, CP need a different approach to AIS treatment. Although, according to the European Stroke Organisation (ESO) guidelines, cancer is not an absolute contraindication for intravenous thrombolysis (IVT), caution is required due to an increased risk of bleeding in some cases [7]. Polish guidelines recommend against the use of IVT in patients with high-bleeding-risk cancer [8]. In those patients, mechanical thrombectomy (MT) is a treatment of choice provided they are otherwise eligible for the procedure.

Nevertheless, the data on the efficacy and outcomes of MT in CP come mostly from single-centre studies, and the results are not unanimous. More research in this topic is needed, especially concerning long-term outcomes.

Aim

The aim of our study was to assess long-term outcomes (up to 365 days after stroke onset) of CP treated with MT in the Comprehensive Stroke Centre (CSC) of the University Hospital in Krakow, Poland.

Material and methods

We conducted a retrospective analysis of prospectively collected data of patients with AIS admitted to the CSC of the University Hospital in Krakow from January 2019 to December 2021. The data were collected as a part of the study "Identification and clinical validation of biomarkers for long-term outcome after cerebral ischemia (iBioStroke)" (https://www.neuron-eranet.eu/wp-content/uploads/iBioStroke.pdf). Stroke diagnosis was consistent with the AHA/ASA definition [9]. In the analysis we included all patients treated with MT in this period of time.

We divided the subjects into 2 groups:

1. Patients with cancer (CP), defined as having a diagnosis of malignancy within 5 years preceding the onset of AIS and undergoing cancer-specific treatment during this time or being in the process of qualification for it.
2. Control group, comprising of remaining patients, not fulfilling CP criteria.

In all patients we collected the following data: demographics (age and sex) and stroke risk factor profile (hypertension, diabetes mellitus, history of myocardial infarction, atrial fibrillation, history of smoking, history of stroke or transient ischaemic attack, hypercholesterolemia, obesity) – the definitions of particular risk factors were presented in our previous study [10].

Stroke severity at admission was assessed using the National Institutes of Health Stroke Scale (NIHSS). Infarct and penumbra volumes at admission were estimated using computed tomography (CT) perfusion postprocessing analysis using iRAPID programme. Qualification for reperfusion treatment was performed according to the selection and eligibility criteria of the current ESO guidelines on intravenous thrombolysis and mechanical thrombectomy in AIS [7, 11]. MT-preceding treatment with IVT was noted. We analysed the length of hospitalisation as well as the occurrence of medical complications after MT – pneumonia, urinary tract infection (UTI) and venous thromboembolism (VT) – as described in a previous study from our centre [12].

We noted the occlusion site (anterior or posterior circulation). We analysed time from stroke onset to groin puncture (SO-GP), time from groin puncture to reperfusion (GP-RT) and the radiological effect of reperfusion assessed using a modified Treatment in Cerebral Ischaemia scale (mTICI), with scores of 2b-3 considered successful reperfusion. Post-treatment haemorrhagic complications were noted.

Short-term outcomes were defined as in-hospital mortality, NIHSS score and good functional outcome at discharge defined as a result in modified Rankin Scale (mRS) of ≤ 2. We also assessed mortality and the achievement of good functional outcome in long-term observation, that is in 90-day and 1-year follow-up. mRS score after discharge was obtained either during scheduled visits in the outpatient clinic of our Centre or through telephone interviews with patients or their family members/caregivers.

The study was approved by the Jagiellonian University Ethical Committee (decision number 1072.6120.118.2020, 28.05.2020). All procedures were performed in accordance with the Declaration of Helsinki. Informed consent was not required. Financial support was provided by the iBioStroke grant (Identification and clinical validation of biomarkers for long-term outcome after cerebral ischaemia, ERA-NET-NEURON/21/2020, K/NCB/00057) and Jagiellonian University Medical College grant (N41/DBS/000837).

Statistical analysis

We compared gathered data between CP and the control group. Statistical analysis was conducted using Statistica software version 12.5 (TIBCO Software Inc.) and PS Imago Pro 9.0 Programme. The data were presented in two forms: categorical data were expressed as counts and percentages, while continuous data were presented as mean and standard deviation (SD) or median and interquartile range (IQR). For comparisons of categorical data, two-tailed χ^2 statistics with Yates correction was used. Continuous variables were tested for normality using Kolmogorov-Smirnov test. For normally distributed data, *t*-Student test was used to compare between groups and for non-normally distributed data, Mann-Whitney *U* test was performed. The threshold for statistical significance was set at a two-sided *p*-value of less than 0.05.

Results

From 2019 to 2021 there were 593 patients with AIS treated with MT in our Centre. The patients had a median age of 70 years (IQR = 17) and there was a small predominance of male sex (52.4%). IVT before MT was received by 338 (57.0%) patients.

We identified 35 CP (5.9%). Their characteristics are presented in Table I.

There were no significant differences between CP and the control group in age and sex distribution. The two groups had a similar stroke risk factor profile. Neurological deficit at admission assessed using NIHSS, as well as infarct and penumbra volumes at qualification for MT (available in 530 patients) were comparable. There were no significant differences concerning location of occlusions. CP received treatment with IVT less frequently (25.7% vs. 59.1%, $p < 0.001$). Among 26 CP disqualified from IVT, malignancy was the primary reason for disqualification in 3 (11.5%) patients. Other reasons were prior intake of anticoagulants in 7 (26.9%) patients, a recent surgery in 5 (19.2%), stroke onset ≥ 4.5 h or unknown in 3 (11.5%), active bleeding in 3 (11.5%), presence of subacute stroke lesions in different vascular areas in 2 (7.7%), low platelet count in 2 (7.7%) and in 1 patient (transferred from another centre) the reason for the lack of IVT treatment was unknown. Times from stroke onset to groin puncture and from groin puncture to reperfusion were similar in the two groups. There were no differences in the duration of the hospitalisation, nor the occurrence of pneumonia, UTI and VT during hospitalisation.

Short-term outcomes of MT were similar in CP and the control group. There were no significant differences in the percentage of successful reperfusions. The data on the method of achieving reperfusion were available in 33 CP. In one of them, none of the methods was eventually used as it was impossible to reach the site of occlusion despite many attempts. Aspiration was used in 12 patients, a stent retriever in 5 patients and a combination of both in 15 patients, with successful reperfusion in 83.3%, 80% and 93.3%, respectively. The groups of CP and controls did not differ in the rates of intracranial haemorrhages (data available in 566 patients), or mortality during hospitalisation. The total in-hospital mortality rate was 13.7% and 42.0% of all in-hospital deaths occurred in patients with secondary intracranial haemorrhage. We analysed the subgroup of patients treated with both IVT and MT with available control neuroimaging ($n = 339$) and there were no statistically significant differences in ICH rate between CP and controls (11.1% vs. 24.2%, $p = 0.47$). Median NIHSS score and good functional outcome rate at discharge were similar.

90-day follow-up was available in 578 (97.5%) patients. There were no significant differences between the groups in mortality and the percentage of patients achieving good functional outcome.

365-day follow-up was available in 557 (93.9%) patients. CP had higher mortality in a year-long observation (48.6% vs. 29.5%, $p = 0.023$) but the percentage of patients achieving good functional outcome remained similar in CP and the control group.

Group comparison is summarized in Table II.

Discussion

Our study showed that despite one-year mortality after MT is higher in CP, the functional outcomes are satisfactory, thus proving the benefits from the procedure in AIS patients with cancer.

Similarly to our study, previous research shows that about 6–7% of MT-treated AIS patients have concomitant cancer [13]. Interestingly, studies show that thrombi extracted during MT in patients with cancer have a distinct histopathological structure, which may impact the course of the procedure [13]. A study by Jeon *et al.* showed that in patients with cancer-related stroke, contact aspiration is more effective in achieving reperfusion during MT than using a stent retriever [14]. In our group, the highest rate of successful recanalizations among CP was observed when using both aspiration and a stent retriever, but the small sample size and different inclusion criteria may have influenced the results.

Studies analysing MT outcomes in CP either assess all patients with active cancer or a subgroup of patients with cancer-related stroke (CRS). CRS is defined as a cryptogenic stroke (with no evidence of conventional stroke mechanisms) in a patient with malignancy, with features of hypercoagulation (elevated D-dimer level or VT) and/or infarctions present in multiple vascular territories [15]. Studies evaluating outcomes of MT in patients with CRS (defined as such) found that they presented with higher mortality and worse functional outcome in long-term observation, both compared to patients without cancer [16, 17], and patients with cancer and stroke due to a different aetiology [18]. In a study by Jung *et al*., 90-day outcomes of MT in CRS patients were very poor, with a good clinical outcome achieved only in 16% of patients and the mortality rate of 63% [16].

In our study we decided to analyse all patients with current malignancy, not necessarily advanced or metastatic, we also did not narrow our analysis to patients with CRS (as defined above) as some conventional stroke mechanisms, such as carotid atherosclerosis or atrial fibrillation may also be a complication of cancer [19] or its treatment [20]. We believe that such an analysis is more useful for clinical practice as the stroke mechanism is very commonly unknown while qualifying the patient for the procedure of MT.

Table I. Individual characteristics of cancer patients treated with mechanical thrombectomy

No.	Sex, age	Type of cancer	Treatment	Metastases	Outcome at discharge	mRS after 90 day	mRS after 1 year
1	M, 77	Colon cancer	Surgical procedure: laparoscopic hemicolectomy (2018). Palliative chemotherapy – after the first cycle (2019)	Liver and peritoneum metastases, suspicion of local recurrence.	NIHSS = 6 mRS = 3	mRS = 3	mRS = 6
2.	F, 66	Ovarian cancer	Surgical procedure: exploratory laparotomy (2019). Stroke before qualifying for adjuvant treatment	Peritoneum and pelvis metastases	mRS = 6	mRS = 6	mRS = 6
3.	F, 67	Ovarian cancer (folliculoma)	Surgical procedure: ovariohysterectomy (2015). Chemotherapy complicated by pulmonary embolism and deep vein thrombosis (after 2 cycles) – 2015	Not found	NIHSS = 14 mRS = 4	mRS = 6	mRS = 6
4.	M, 65	Bladder cancer	Surgical procedure: radical cystectomy (2018)	Not found	mRS = 6	mRS = 6	mRS = 6
5.	M, 77	Gall bladder cancer	Surgical procedure: cholecystectomy (2019). Chemotherapy (2019)	Liver metastases	NIHSS = 1 mRS = 2	mRS = 5	mRS = 6
6.	F, 83	Breast cancer Invasive carcinoma NST grade G2 pT2 N0(i-) L0V0 R0	Surgical procedure: breast-conserving surgery combined with sentinel lymph node dissection (2016). Adjuvant radiotherapy. Hormone therapy	Not found	NIHSS = 0 mRS = 0	mRS = 0	mRS = 0
7.	M, 79	Lung cancer (non-small cell carcinoma)	Stroke before qualifying for treatment (2019)	Not found	NIHSS = 2 mRS = 4	mRS = 1	mRS = 1
8.	M, 71	Pancreatic cancer	Surgical procedure: biopsy of the head of the pancreas (2019). Chemotherapy (2019)	Liver and liver hilum lymph nodes metastases, suspicion of dissemination to the lungs	NIHSS = 1 mRS = 0	mRS = 1	mRS = 1
9.	F, 87	Breast cancer Carcinoma ductale inf. pT1N1M0	Surgical procedure: mastectomy. Hormone therapy (2017)	Not found	NIHSS = 23 mRS = 5	mRS = 6	mRS = 6
10.	F, 69	Endometrial cancer	Surgical procedure: hysterectomy (2017). Adjuvant radiotherapy	Not found	NIHSS = 0 mRS = 0	mRS = 0	mRS = 0
11.	F, 77	Gall bladder cancer	Surgical procedure: cholecystectomy (2015)	Not found	mRS = 6	mRS = 6	mRS = 6
12.	F, 46	Stomach cancer	Palliative chemotherapy (2020). Surgical procedure: hysterectomy (2020)	Left ovary and liver lymph nodes metastases	NIHSS = 0 mRS = 0	mRS = 0	mRS = 6
13.	F, 78	Bladder cancer (urothelial cancer)	Surgical procedure: transurethral resection of bladder tumour (2020)	Not found	NIHSS = 1 mRS = 1	mRS = 1	mRS = 0
14.	F, 79	Breast cancer Invasive carcinoma NST cT4bN2Mx	Surgical procedure: biopsy (2016). Palliative hormone therapy	Lung metastases. Local recurrence	NIHSS = 16 mRS = 5	mRS = 5	mRS = 6
15.	M, 66	Retroperitoneal sarcoma	Surgical procedure (2018). Chemotherapy (2018–2020)	Lung metastases	NIHSS = 4 mRS = 5	mRS = 3	mRS = 1
16.	F, 65	Bladder cancer and urothelial cancer of the renal pelvis. pT1 N0 LV0 R0	Surgical procedure: laparoscopic radical cystectomy with hysterectomy and adnexectomy and left-sided nephroureterectomy with urinary diversion by right-sided ureterocutaneostomy (2021)	Not found	NIHSS = 3 mRS = 1	mRS = 2	mRS = 2

Table I. Cont.

No.	Sex, age	Type of cancer	Treatment	Metastases	Outcome at discharge	mRS after 90 day	mRS after 1 year
17.	F, 74	Renal clear cell carcinoma p T3a R0 LV0 Grade: G2	Surgical procedure: nephrectomy (2017)	Not found	NIHSS = 12 mRS = 5	mRS = 5	mRS = 6
18.	F, 61	Ovarian cancer pT3bLV1 Endometrial cancer pT1aLV0R0	Surgical procedure: hysterectomy with adnexa (2021). Stroke before qualifying for adjuvant treatment	Peritoneum metastases	NIHSS = 12 mRS = 5	mRS = 2	mRS = 1
19.	M, 62	Bladder cancer	Surgical procedure: transurethral resection of bladder tumour (2020)	Not found	NIHSS = 1 mRS = 1	mRS = 1	mRS = 0
20.	F, 83	Bifocal colon and rectal cancer	Surgical procedure: right hemicolectomy and anterior resection of the rectum (2020). Adjuvant radiotherapy (2020)	Not found	NIHSS = 4 mRS = 1	mRS = 0	mRS = 0
21.	M, 89	Prostate cancer	Surgical procedure: biopsy (2021). Radiotherapy (2021)	Not found	NIHSS = 7 mRS = 5	mRS = 6	mRS = 6
22.	M, 68	Prostate cancer	Surgical procedure: biopsy (2020). Radiotherapy (2021)	Not found	NIHSS = 5 mRS = 2	mRS = 1	mRS = 1
23.	F, 65	Colon cancer	Surgical procedure: hemicolectomy (2021). Chemotherapy (2021)	Not found	NIHSS = 3 mRS = 1	mRS = 1	mRS = 1
24.	M, 76	Laryngeal cancer	Surgical procedure (2018)	Not found	NIHSS = 3 mRS = 1	mRS = 1	mRS = 0
25.	F, 82	Basal cell carcinoma of the skin of the nose	Surgical procedure (2021)	Not found	NIHSS = 2 mRS = 1	mRS = 0	mRS = 0
26.	M, 87	Prostate cancer	Surgical procedure: biopsy (2020). Radiotherapy (2021)	Not found	NIHSS = 19 mRS = 5	mRS = 6	mRS = 6
27.	M, 66	Bladder cancer	Surgical procedure: radical cystectomy (2019)	Not found	mRS = 6	mRS = 6	mRS = 6
28.	M, 62	Adenocarcinoma of the sigmoid colon	Surgical procedure: sigmoidectomy (2021). Chemotherapy (2021)	Liver metastases	mRS = 6	mRS = 6	mRS = 6
29.	F, 71	Breast cancer NST G2 pT1bN2a	Surgical procedure: breast-conserving surgery combined with sentinel lymph node dissection (2017). Adjuvant radiotherapy. Hormone therapy	Lymph node metastases	NIHSS = 0 mRS = 1	mRS = 1	mRS = 1
30.	M, 86	Prostate cancer	Surgical procedure (2021). Radiotherapy (2021)	Bone metastases	mRS = 6	mRS = 6	mRS = 6
31.	F, 69	Lung cancer (non-small cell carcinoma, adenocarcinoma)	Stroke before qualifying for treatment (2021)	Bone metastases	NIHSS = 2 mRS = 1	mRS = 6	mRS = 6
32.	F, 85	Breast cancer	Surgical procedure: mastectomy (2021). Hormone therapy	Not found	NIHSS = 7 mRS = 3	mRS = 2	mRS = 1
33.	F, 77	Breast cancer	Surgical procedure: breast-conserving surgery combined with sentinel lymph node dissection (2021)	Not found	NIHSS = 11 mRS = 3	mRS = 3	mRS = 5
34.	M, 44	Cancer of the left parotid gland	Surgical procedure (2019). Radiotherapy. Chemotherapy	Lung metastases	NIHSS = 7 mRS = 2	mRS = 1	mRS = 1
35	F, 58	Ovarian cancer	Chemotherapy (2021)	Liver, lymph nodes and chest wall metastases	mRS = 6	mRS = 6	mRS = 6

M – male, F – female, NIHSS – National Institutes of Health Stroke Scale, mRS – modified Rankin Scale.

Table II. Comparison of patients with cancer (CP) and the control group

Parameter	CP (*n* = 35)	Control group (*n* = 558)	*P*-value
Demographics:			
Age [years] median (IQR)	71 (14)	70 (17)	0.39
Female sex, *n* (%)	21 (60.0)	261 (46.8)	0.16
Cardiovascular risk factors, *n* (%):			
Hypertension	24 (68.6)	389 (69.7)	1.00
Diabetes mellitus	7 (20.0)	118 (21.1)	1.00
History of myocardial infarction	2 (5.7)	73 (13.1)	0.29
Atrial fibrillation	13 (37.1)	237 (42.5)	0.60
Hypercholesterolemia	5 (14.3)	131 (23.5)	0.23
History of smoking	5 (14.7)	119 (21.3)	0.40
Prior stroke or TIA	5 (14.3)	66 (11.8)	0.79
Obesity	5 (14.3)	111 (19.9)	0.52
Peripheral artery disease	4 (11.4)	54 (9.7)	0.77
Stroke severity at admission:			
Initial NIHSS, median (IQR)	14 (10)	16 (10)	0.39
Infarct volume [ml], median (IQR)	8.5 (32)	7 (25)	0.69
Penumbra volume [ml], median (IQR)	70 (61)	91 (76)	0.18
Occlusion site, *n* (%):			
Anterior circulation	32 (91.4)	484 (86.7)	0.42
Posterior circulation	3 (8.6)	74 (13.3)	0.42
Stroke treatment:			
Intravenous thrombolysis, *n* (%)	9 (25.7)	330 (59.1)	< 0.001
Onset-to-groin-puncture time [min] median (IQR)	270 (145)	295 (145)	0.38
Puncture-to-reperfusion time [min] median (IQR)	55 (36)	60 (45.25)	0.32
Complications, *n* (%):			
Pneumonia	10 (28.6)	149 (26.7)	0.84
Urinary tract infection	5 (14.3)	92 (16.5)	0.82
Venous thromboembolism	2 (5.7)	8 (1.4)	0.11
Short-term outcomes:			
Successful reperfusion, *n* (%)	28 (80.0)	492 (88.3)	0.18
Intracranial haemorrhage, *n* (%)	5 (14.3)	121 (21.7)	0.40
Duration of hospitalization [days] median (IQR)	9 (6)	9 (4)	0.68
NIHSS at discharge, median (IQR)	3.5 (8)	4 (9)	0.69
Good functional outcome at discharge, *n* (%)	15 (42.9)	272 (48.7)	0.60
Mortality during hospitalization, *n* (%)	7 (20.0)	74 (13.3)	0.31
90-day outcomes (*N* = 578):			
Good functional outcome at 3 months, *n* (%)	17 (48.6)	311 (57.3)	0.38
Mortality at 3 months, *n* (%)	12 (34.3)	121 (22.3)	0.14
365-day outcomes (*N* = 557):			
Good functional outcome at 1 year, *n* (%)	17 (48.6)	318 (60.9)	0.16
Mortality at 1 year, *n* (%)	17 (48.6)	156 (29.9)	0.024

TIA – transient ischaemic attack, NIHSS – National Institutes of Health Stroke Scale.

Studies comparing MT outcomes of AIS patients with active cancer (not necessarily fulfilling CRS criteria) compared to those without cancer produce mixed results. In most of them there is no difference in the successful reperfusion rate, with a few studies pointing towards higher in-hospital mortality [21], higher percentage of intracranial haemorrhage [22, 23], and worse functional outcome in 90-day observation [18, 24, 25] among CP. Many of the studies show higher mortality in CP in 3-month follow-up [23, 25–31], although in some of them, such as in ours, 90-day mortality and functional outcomes remained comparable [22, 32, 33]. Two studies evaluating the outcomes after any form of reperfusion therapy (IVT or/and MT) in CP also showed similar mortality and good functional outcome rates after 3 months [32, 33].

The largest study in this topic so far was conducted by Shapiro *et al*., who analysed the outcomes of 8935 patients with CP undergoing MT, unfortunately not reporting long-term outcomes. There was also a comparable percentage of haemorrhagic complications of MT and no significant differences found in adjusted analysis in functional outcome at discharge and in-hospital mortality between MT-treated patients with and without cancer [34].

There were two other studies assessing a year-long outcome of MT in CP. One was performed by Oki *et al*. and evaluated outcomes of 12 patients with active cancer treated with MT, of whom 11 died within 365 days from stroke onset. The study did not have a control group [35]. The other one was performed by Yoshimoto *et al*. and showed a comparable good functional outcome rate after MT in patients with active cancer in 3- and 12-month follow-up, but with higher 90-day and 365-day mortality in this group [36].

A systematic review by Aloizou *et al*. including 18 studies showed that although the patient condition at discharge was comparable, 90-day outcomes (mortality and functional condition) were worse in CP, nevertheless it is still unclear whether it resulted from stroke complications or the malignancy itself [37]. Similar conclusions were presented in another, smaller systematic review with meta-analysis by Duan *et al.* [38]. Another systematic review with meta-analysis by Caimano *et al.* showed that MT in CP effected in higher 3-month death and dependency rates as well as higher occurrence of any ICH after the procedure [39].

Results of some other studies suggest that outcomes may depend on the severity of the neoplasm. Aboul-Nour *et al.* found that MT-treated patients with advanced, metastatic cancer had higher in-hospital mortality and suffered from more infectious and thrombotic complications than patients without cancer [40], but, on the other hand, Pana *et al.* compared the outcomes of MT in patients with metastatic and non-metastatic cancer, which were similar at discharge [41].

Interesting findings were described in an observational study by Davies *et al*., where patients with advanced or metastatic cancer who were treated with IVT and/or MT had a median survival of 6.2 months, whereas those who did not receive reperfusion therapies had a median survival of only 1.3 months. Although there may be a selection bias (patients who qualified for causative stroke treatment may have been in a generally better condition), the result of this study may add to the results of the previous ones, encouraging use of reperfusion therapies (especially MT, as having fewer contraindications) in patients even with advanced systemic cancer disease [42]. What is also interesting, Shalabi *et al.* found that efficacy of MT in CP was not dependent on the cancer type [43].

Our study adds up to current evidence on the benefits of MT in CP. Nevertheless, we must note that it has some important limitations. As the data analysis was retrospective, we did not have detailed data on the malignancy staging and the type of cancer treatment in some cases (when the patient was undergoing therapy in another centre). The data on the causes of death among CP in long-term follow-up were also unavailable. As the CP group was small, and the number of patients who died even smaller, we could not perform a multivariate analysis to recognise factors associated with mortality among CP. A relatively small sample size is probably the reason why some of our results did not reflect the findings of other studies in this topic, which showed that among stroke patients CP have fewer cardiovascular risk factors [44] and more often develop VT [40].

Conclusions

AIS patients with cancer have higher mortality after MT in a year-long follow-up, but the percentage of good functional outcomes is comparable to non-cancer patients both in short- and long-term observation. Treatment with MT seems beneficial for AIS patients with concomitant malignancy. Cancer should not discourage clinicians from pursuing endovascular stroke treatment. The treatment decisions in CP with AIS should be made individually, considering potential complications and other prognostic factors, both neurological and oncological.

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Conflict of interest

The authors declare no conflict of interest.

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