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Factors affecting mechanical thrombectomy outcome in acute ischemic stroke patients: an Egyptian sample

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Abstract

Background: Stroke constitutes a major health problem worldwide, nowadays endovascular treatment is considered to be a standard of care in acute ischemic stroke patients with large vessel occlusion, accurate prediction of outcome of thrombectomy is essential for health care providers, patients and families. We studied different clinical and radiological variables that could predict functional outcome in stroke patients after thrombectomy. Thirty-four consecutive ischemic stroke patients were included, received intravenous tissue plasminogen activator (iv-tpa), then mechanical thrombectomy was done. Patients were clinically assessed at admission with National Institute of Health Stroke Scale (NIHSS) then evaluated by the Alberta Stroke Program early computerized tomography (CT) score (ASPECTS), clot burden scale (CBS) and collateral score (CS) in multiphase computerized tomography angiography (CTA) then good and poor outcomes at 3 months were defined by Modified Rankin Scale (MRS) of 0–2 and 3–6 points, respectively.

Results: Factors associated with good outcome (MRS 0–2) were lower admission NIHSS score ($p < 0.037$), small infarct core aspects ≥ 6 ($p < 0.001$), low clot burden (CBS 7–10) ($p = 0.046$) good collaterals (2–3) ($p = 0.038$) and absence of post-procedure hemorrhage ($p < 0.0005$).

Conclusions: Low admission NIHSS score, absence of post-procedure hemorrhage, small infarct core, low clot burden and good collaterals are reliable factors for good clinical outcome.

Keywords: Mechanical thrombectomy, Ischemic stroke, Modified Rankin Scale

Background

With an annual incidence of 270,000–960,000, stroke is the second most frequent cause of death and the most frequent cause of disability in Egypt [1]. Globally, about 16 million new cases of stroke and 62 million stroke survivors were estimated in 2005, and this is expected to increase to over 23 million new stroke cases by 2030 in the absence of significant global public health response [2, 3]

The burden of stroke in Africa is high and still increasing [4], In Egypt the incidence and prevalence of stroke are high and more effort is needed to cope with such huge burden [5].

The current treatment paradigm of thrombolysis within four and half hours of symptom onset carries a risk of hemorrhage [6], and is only given in 2 to10% of acute ischemic strokes [7], intravenous treatment is effective in fewer than 30% of large vessel occlusions [8].

Primary intravenous therapy in large vessel occlusion resulted in a recanalization rate in only 10.6%, making endovascular treatment either unnecessary or impossible [9].

Endovascular treatment using stent retriever devices offer emergent reperfusion with higher recanalization rates and the potential for treatment outside the 4.5 h window [10], and mechanical thrombectomy (MT) with stent-retriever is considered the treatment of

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choice for any large vessel occlusion (LVO) according to guidelines[11]..

Proximal occlusions of the major cerebral arteries account for more than one-third of cases of acute stroke [12], however, the efficacy of intravenous thrombolysis in these cases is limited [13].

Recent trials have shown the significant benefit of endovascular treatment in patients with acute ischemic stroke due to proximal cerebral arterial occlusion when performed within 6 h after stroke onset [11].

The proportion of patients with independent functional outcome after 3 months is significantly higher compared to intravenous therapy alone. Many clinical and radiological variables have been analyzed to help predict favorable outcome after stroke however, the heterogeneity in treatment has often been a limiting factor in the definition of relevant outcome predictors [14].

Many prognostic factors are correlated with the clinical outcome in patients with acute ischemic stroke. Biological factors (such as age, sex), comorbidity, and premorbid disability, have been reported to be associated with the clinical outcome [15, 16].

Clinical factors at presentation, such as stroke severity, blood pressure, blood glucose level, and time from stroke onset, have also been reported to be prognostic factors [17, 18].

There are also neuroimaging prognostic factors, such as the Alberta Stroke Program early CT score (ASPECT), ischemic core volume, mismatch of ischemic core and hypoperfusion volume, location of the occlusion, thrombus length, thrombus characteristics, and collateral flow status [19, 20]. The aim of this work is to search for clinical or radiological variables that could predict clinical outcome after mechanical thrombectomy in acute ischemic stroke patients.

Patients and methods

Patients

This study was conducted on 34 patients with acute ischemic cerebrovascular stroke treated with mechanical thrombectomy admitted to neurology department, Alexandria university affiliated hospitals network from (January 2017—December 2017). The age range of patients included in this study was (28- 81) years, and their mean age was (59.56 ± 12.85) year. They were 15 females (44.2%) and 19 males (55.8%). The study was approved by the Menoufia University ethics committee on December, 2016.

Inclusion criteria were: prestroke Modified Rankin Scale (MRS) score 0 to 1, acute ischemic stroke receiving intravenous r-tpa within 4.5 h of onset, causative occlusion of the internal carotid artery, basilar artery, middle cerebral artery (MCA)m1–m2, age ≥ 18 years, NIHSS score ≥ 6, treatment can be initiated by groin puncture within 24 h of symptoms onset after CT perfusion (CTP) if presented after 6 h from onset or wake-up stroke, it was done as soon as possible after IV thrombolysis, and informed written consent was taken from the patients or their caregivers.

Exclusion criteria were: patients with hemorrhagic stroke, patients with transient ischemic attack (TIA), and patients with ischemic stroke not fulfilling criteria for mechanical thrombectomy.

Methods

Clinical assessment in the form of careful history taking, general and neurological examination, National Institute of Health Stroke Scale (NIHSS) [21] was done for all patients to asses stroke severity at admission, also Modified Rankin Scale (MRS) [22] was done 3 months after stroke to assess clinical outcome and patients were divided into good outcome (MRS 0–2) and bad outcome (MRS 3–6).

Laboratory workup at the onset included complete blood count, kidney function, and bleeding profile. Imaging studies were non-contrast computerized tomography (ncCT) to the Alberta Stroke Programme early CT score (ASPECT), and multiphasic CT angiography brain to asses clot site and clot burden score (CBS) [23] and collateral score (CS) [24].

Using CTA, residual flow within clot was graded:

> Grade 0: clot with no contrast permeation and attenuation similar to that in surrounding brain parenchyma.
> Grade I: clot appearing denser than surrounding brain parenchyma, with contrast potentially permeating through the clot.
> Grade II: hairline or streak of well-defined contrast across the partial or complete length of clot.

Endovascular treatment was done using angiography suite under general anesthesia or conscious sedation after evaluation by anesthesia team. Patients were preferentially treated under conscious sedation except in case of agitation or operative risk of aspiration.

The choice of mechanical thrombectomy technique was selected on an individual-patient basis by the attending physician, stent-retrievers (Solitaire, Medtronic, USA or Trevo, Stryker, USA) or a Direct Aspiration First Path Technique (ADAPT) or combined technique [25].

Step 1: Femoral arterial puncture and sheath insertion; femoral puncture using femoral sheath 8-French. Then,

the puncture needle enters the artery slightly higher than the skin entry site with an angle about 30° from the horizontal. Advancement of the needle slowly up the artery is followed by the gentle introduction of a straight or a J-tipped guidewire into the artery. After the guidewire is positioned in the iliac artery, the needle is removed with firm hand pressure applied over the puncture site while the sheath is placed over the wire.

Step 2: Guiding catheter, guide wire placement; a guiding catheter include either a 6-French or a 8-French guiding catheter. A 120-cm diagnostic catheter, 5-French, is inserted coaxially and is used to select the common carotid artery in the anterior circulation occlusion, using a Terumo guidewire 0.35 after which the guiding catheter is advanced coaxially over the diagnostic catheter.

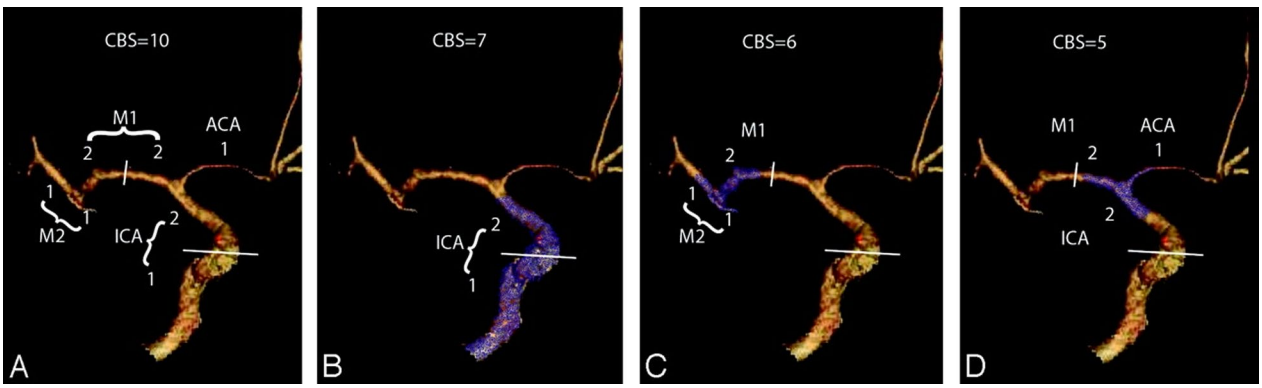
Step 3: Advancement distal access catheter; the micro catheter 2.0-French or a 2.3-French and micro guide wire 0.014 or a 0.016 in can be advanced through the system up to the occlusion. Inside aspiration catheter (distal access catheter) 5-French (Navien catheter; Covidien) a flexible, single-lumen, a straight tip configuration. Then, distal access catheter is advanced over it up to the thrombus to make a wedge between the tip of the catheter and the thrombus. Thereafter, the proximal hub of the distal access catheter directly is connected to a 50-mL syringe.

This process could be repeated until successful reperfusion is achieved. It is required to perform at least 3 attempts at revascularization using the assigned endovascular technique before switching to another endovascular procedure rescue therapy if needed and in accordance with good practice recommendations. Permitted rescue techniques were contact aspiration, stent retriever, combined contact aspiration and stent retriever, and angioplasty with or without stenting.

NIHSS: 0: no stroke, 1–4: minor stroke, 5–15: moderate stroke, 16–20: moderate to severe stroke and 21–42: severe stroke.

MRS: 0: No symptoms, 1: No significant disability. Able to carry out all usual activities, despite some symptoms, 2: Slight disability. Able to look after own affairs without assistance, but unable to carry out all previous activities, 3: Moderate disability. Requires some help, but able to walk unassisted, 4: Moderately severe disability. Unable to attend to own bodily needs without assistance, and unable to walk unassisted, 5: Severe disability. Requires constant nursing care and attention, bedridden, incontinent and 6: Dead.

Clot burden score:



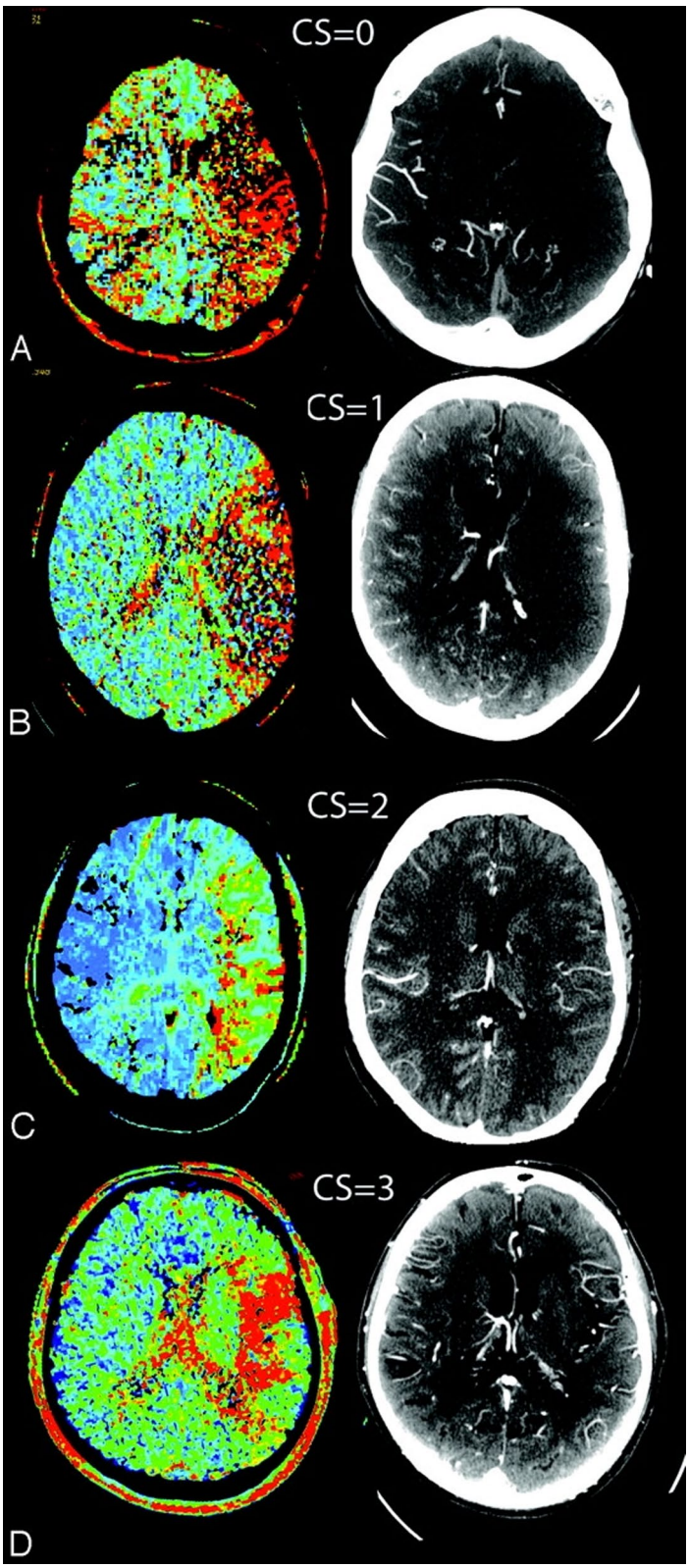
Step 4: Manual aspiration with a syringe, then catheter retrieval maintaining aspiration force.

First, we tried to use the large maximize suction power. Second, we tried to keep the direction of the tip of distal access catheter parallel to the presumptive path of the occluded vessel for prevention of direct contact between the tip and the endothelium.

A, A 10-point score is normal, implying absence of thrombus. Two points (as indicated) are subtracted for thrombus found on CTA in the supraclinoid ICA and each of the proximal and distal halves of the MCA trunk. One point is subtracted for thrombus found in the infraclinoid ICA and A1 segment and for each affected M2

branch. *B*, Occlusion of infra- and supraclinoid ICAs with a CBS of 7. *C*, Distal M1 and 2 M2 branch occlusions produce a CBS of 6. *D*, Occlusion of the terminal ICA, proximal M1, and A1, with a resultant CBS of 5.

Collateral score:



MTT and CTA source images (CTA-SI) of 4 different cases, each demonstrating prolonged MTT from a left MCA territory ischemia. CS grading is demonstrated for each collateral grade. A, Absence of vessels on CTA-SI is consistent with a CS of 0. B, A score of 1 indicates collateral supply filling ≤ 50% but > 0% of the occluded MCA territory. C, A score of 2 is given for collateral supply filling > 50% but < 100% of the occluded MCA territory. D, A score of 3 is given for 100% collateral supply of the occluded MCA territory.

Statistical analysis was done using IBM SPSS software package version 20 (Armonk, NY: IBM Corp, USA). Qualitative data were described using number and percent. The Kolmogorov- Smirnov test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level. Chi-square test: for categorical variables, to compare between different groups. Fisher's exact: correction for Chi-square when more than 20% of the cells have expected count less than 5. Student t-test: for normally distributed quantitative variables, to compare between two studied groups. ANOVA with repeated measures: for normally distributed quantitative variables, to compare between more than two periods or stages, and post hoc test (Bonferroni adjusted) for pairwise comparisons. Mann Whitney test: for abnormally distributed quantitative variables, to compare between two studied groups.

Results

Table 1 shows baseline clinical and demographic characteristics of patients. Post-procedural hemorrhage occurred in 5 patients, was minimal, its timing was related to the thrombectomy procedure itself due to the reperfusion injury, it showed non-statistically significant result.

Poor functional outcome is more with male sex ($p = 0.05$), moderate to severe stroke ($p < 0.037$), NCCT aspects < 6 ($p < 0.001$), long clot (CBS, 0–6) ($p = 0.456$), poor collaterals (CS 1) ($p = 0.038$) (Table 2).

Table 3 confirms the results of the predictors of the clinical outcome.

Table 1 Baseline clinical and demographic characteristics of patients ($n = 34$)

	Participants n (34)	
	n	**%**
Age	59.56 ± 12.85	
Sex		
Male	19	55.8%
Female	15	44.2%
Risk factors		
Present	33	97
Absent	1	3
Dyslipidemia	22	64.7
Diabetes mellitus	28	82.4
Atrial fibrillation	28	82.4
Hypertension	29	85.3
NIHSS (admission)		
Minor	0	0
Moderate	17	50
Moderate–severe	16	47
Severe	1	3
MRS (90d)		
0–2 (favorable outcome)	29	85.3
3–6 (unfavorable outcome)	5	14.7
Ncct aspects		
< 6	11	32.4
≥ 6	23	67.6
Collateral grading score		
1	11	32.4
2	13	38.2
3	10	29.4
Clot burden score		
0–6	18	52.9
7–10	16	47.1
Clot site		
ICA-T	11	32.4
MCA-M1/M2	12	35.3
MCA-M1	6	17.7
BA	3	8.8
ICA-CEX	2	5.8
Post-procedure hemorrhage		
Yes	5	14,7
No	29	85.3

NIHSS National Institute of Health Stroke Scale, *ASPECT* Alberta Stroke Program Early CT finding, *NCCT* non-contrast ct, *MRS* Modified Rankin Scale, *ICA-T* internal carotid t occlusion, *MCA* middle cerebral artery, *BA* basilar artery, *ICA-CEX* cervical internal carotid

Discussion

Clinical and radiological variables that could predict clinical outcome after mechanical thrombectomy in acute ischemic stroke patients were studied in this work in order to find significant predictors.

In our study, good functional outcome was achieved in 29 patients (85.3%) which may be more than that is mentioned by Campbell et al. [26], 72%, Goyal et al. [27], 60%, Menon et al. [28], 52%. That could be explained by the younger age of patients in our study (59.56 ± 12.85) and low mean NIHSS (14.76 ± 3.276) score and most of our patients were males 19 (55.8%), so patients criteria were somewhat different between studies.

Table 2 Predictors of clinical outcome data ($n=34$)

	Outcome (MRS 90)				Test	*P* value
	Favorable, 0–2 ($n=29$)		Unfavorable, 3–6 ($n=5$)			
	n	%	*n*	%		
Age						
Mean ± SD	55.4 ± 14.36		59.62 ± 13.84		Mann–Whitney	0.557(ns)
Sex						
Male	14	48.28	5	100	Fisher's exact	0.05 (s)
Female	15	51.72	0	0		
NIHSS initial						
Minor	0	0	0	0.0		
Moderate	17	58.6	0	0	Chi-square	< 0.037(s)
Moderate–severe	11	37.9	5	100		
Severe	1	3.5	0	0.0		
ASPECT score						
< 6	6	20.7	5	100	Fisher's exact	< 0.001(hs)
≥ 6	23	79.3%	0	0		
Clot burden score						
0–6	13	44.8	5	100%	Fisher's exact	0.0465(s)
7–10	16	55.2	0	0%		
Collateral grading scale						
1	7	24.1	4	80		
2	13	44.8	0	0	Fisher's exact	0.038(s)
3	9	31.1	1	20		
Clot site						
ICA-T	9	31.06	2	40		
MCA-M1/M2	11	37.93	1	20		
MCA-M1	6	20.68	0	0	Chi-square	0.361(ns)
BA	2	6.89	1	20		
ICA-CEX	1	3.44	1	20		
Post-procedure haemorrhage						
Yes	1	3.4%	4	80%	Chi-square	0.602(ns)
No	28	96.6%	1	20%		

NIHSS National Institute of Health Stroke Scale, *ASPECT* Alberta Stroke Program Early CT finding, *NCCT* non-contrast ct, *MRS* Modified Rankin Scale, *ICA-T* internal carotid t occlusion, *MCA* middle cerebral artery, BA: basilar artery, *ICA-CEX* cervical internal carotid, *s* statistically significant, *ns* non-statistically significant

Regarding predictors, we found that higher initial NIHSS ($p<0.037$), pretreatment aspects score (0–6) ($p<0.001$), higher clot burden (p0.0465), bad collateral cirulation ($p=0.038$) and post-procedure cerebral hemorrhage ($p<0.0005$) were associated with unfavorable functional outcome (MRS, 3–6) after mechanical thrombectomy. Our study suggests that these features may be helpful for prognostication and risk stratification for endovascular therapy, also we did not find any statistically significant differences in outcome regarding clot site and residual flow through clot.

Regarding stroke severity, we found a significant association between high NIHSS at admission and unfavorable functional outcome, which is consistent with the results of Goyal et al. [27], Kurre et al. [29], and Barral et al. [30]. High NIHSS is considered to be associated with both proximal occlusion and low collateral circulation [31]; this agreement between different studies denotes the high significance of the initial NIHSS.

Also, regarding pretreatment ASPECTS score we found statistically significant relation between baseline aspects > 6 and good outcome which also agrees with Powers et al. [32], Lapergue et al. [33], and Román et al. [34]. This could be justified as the lower infarct core, the better will be the outcome [35]. So, the guidelines of American Heart Association recommend patients aspects ≥ 6 [36].

Table 3 Multiple regression table for predictors of clinical outcome

	Outcome (MRS 90)				Coefficient	95% CI	*P* value
	Favorable, 0–2 (*n* = 29)		Unfavorable, 3–6 (*n* = 5)				
	n	%	*n*	%			
NIHSS initial					− 0.013	− 0.017–0.010	< 0.045(s)
Minor	0	0	0	0.0			
Moderate	17	58.6	0	0			
Moderate–severe	11	37.9	5	100			
Severe	1	3.5	0	0.0			
ASPECT score					− 0.004	− 0.001–0.02	< 0.0001(hs)
< 6	6	20.7	5	100			
≥ 6	23	79.3%	0	0			
Clot burden score					− 0.1	− 0.05–0.03	0.0154(s)
0–6	13	44.8	5	100%			
7–10	16	55.2	0	0%			
Collateral grading scale					− 0.07	− 0.03–0.005	0.046(s)
1	7	24.1	4	80			
2	13	44.8	0	0			
3	9	31.1	1	20			
Clot site:							
ICA-T	9	31.06	2	40	0.0078	0–0.123	0.563(ns)
MCA-M1/M2	11	37.93	1	20			
MCA-M1	6	20.68	0	0			
BA	2	6.89	1	20			
ICA-CEX	1	3.44	1	20			
Post-procedure hemorrhage							
Yes	1	3.4%	4	80%	0.432	0–0.734	
No	28	96.6%	1	20%			

NIHSS National Institute of Health Stroke Scale, *ASPECT* Alberta Stroke Program Early CT finding, *NCCT* non-contrast ct, *MRS* Modified Rankin Scale, *ICA-T* internal carotid t occlusion, *MCA* middle cerebral artery, BA: basilar artery, *ICA-CEX* cervical internal carotid, *s* statistically significant, *ns* non-statistically significant, *CI* confidence interval

Kurre et al. [29] concluded that high ASPECTS > 6 and low NIHSS were independent predictors of favorable outcome in patients aged ≥ 80 years after mechanical thrombectomy for anterior circulation large vessel occlusion and may support decision-making regarding the treatment modality.

Patients with good collateral circulation status beyond target arterial occlusion are more likely to have salvageable brain tissue than are patients with poorer collaterals [37]. That is what we found in our prospective study using multiphase CTA which also concluded by Menon et al. [28], bc campbell et al. [38], Goyal et al. [39], that patients with poor collaterals are less likely to benefit from endovascular therapy and achieve unfavorable outcome than those with better collaterals. This explains the highly important role of collateral circulation in keeping adequate cerebral perfusion that gives its impact on the outcome.

In our study, CTA-derived assessment of clot extent (CBS) is an independent predictor of clinical outcome in stroke patients after mechanical thrombectomy, patients with smaller clot extent (cbs 7–10) are more likely to have smaller baseline infarcts good clinical outcome, pathophysiologically this translates to a lower likelihood of recanalization for larger and more proximally located thrombi, resulting in consistently worse clinical outcome that is agreed with Horsch et al. [40], Fanou et al. [41], and Treurniet et al. [42].

In our study, we did not find any statistically significant relation between post-procedure hemorrhage and outcome of mechanical thrombectomy which agrees with Hao et al. [43], Jiang et al. [44], Nawabi et al. [45], pathophysiologically, intracerebral hemorrhage after endovascular therapy occurs due to a reperfusion syndrome which is relevant to the degree and time of the reperfusion flow, the time of recanalization and the pretreatment infarct volume [46]. This finding reflects that strict application of guidelines in choosing patients fit for

thrombectomy results in good outcome even if complicated by some hemorrhage.

We did not find statistically significant difference between occlusion site and outcome this was against Kwak et al. [47] and Linfante et al. [48], as they stated that acute ICA or basilar artery occlusion are known to be associated with poor outcomes in particular, distal ICA occlusion and/or tandem occlusions (ICA plus middle cerebral artery (MCA)) carry a worse prognosis than MCA occlusions also in another series, Zaidat et al. [49], examined patients with acute occlusion of the distal ICA treated with iat/iv rt-pa, the mortality rate was 50% despite complete recanalization (80% in the combined iv/ia thrombolysis group and 62% in the group treated with iat alone) we can explain our results to be due to small number of patients with carotid occlusion, small sample size and lower mean age of patients.

Also, we did not find any statistically significant relation between outcome and residual flow through thrombus which is against Menon et al. [50], who concluded that increased thrombus permeability is associated with good clinical outcome, we can explain that this is true mainly with thrombolytic therapies due to more permeable thrombus will allow more diffusability of tpa and in our study 19 patients 55.9% did not receive tpa underwent direct thrombectomy.

Our study has limitations

Sample size (34 patients) was small and larger volume of patients in further studies is recommended, we could not standardize the technique of thrombectomy. We have not assessed other potentially relevant variables such as door to recanalization time, the use of heparin during mechanical thrombectomy, or use of alteplase during procedure.

Conclusions

Low admission NIHSS, absence of post-procedure hemorrhage, small infarct core, low clot burden and good collaterals are reliable factors for good clinical outcome after acute ischemic stroke treated with mechanical thrombectomy.

Abbreviations

IV-TPA: Intravenous tissue plasminogen activator; NIHSS: National Institute of Health Stroke Scale; ASPECTS: Alberta Stroke Program Early CT Score; CBS: Clot burden score; CS: Collaterals score; CTA: Computerized tomography angiography; MRS: Modified Rankin Scale; CTP: Computerized tomography perfusion; TIA: Transient ischemic attack; NCCT: Non-contrast computerized tomography.

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Author contributions

MEE: he designed the work and revised the writings. OYM: he did collection of cases and clinical assessment. MEL: he did the part of discussion and statistical analysis. MSM: he wrote the paper and shared in clinical follow-up of cases. All authors read and approved the final manuscript.

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Availability of data and materials

All related data are available.

Declarations

Ethics approval and consent to participate

Name of the ethics committee (Menoufiya ethics committee) Date of approval; December, 2016 (we don't have a specific number for this approval), and informed written consent was taken from the patients and it's considered one of the inclusion criteria.

Consent for publication

We approve the publication. Regarding data about individual case: Not applicable.

Competing interests

The authors declare that they have no competinginterests.

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