NEUROLOGIA I NEUROCHIRURGIA POLSKA 52 (2018) 359–363

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/locate/pjnns

Original research article

Mechanical thrombectomy: Determining the proportion of eligible acute ischemic stroke patients in the cohort of single academic stroke center

Marcin Wiącek[a,*], Rafał Kaczorowski[a], Bartosz Sieczkowski[a], Natalia Kanas[a], Halina Bartosik-Psujek[a,b]

[a] Department of Neurology, Clinical Regional Hospital No. 2, Rzeszów, Poland
[b] Faculty of Medicine, University of Rzeszów, Poland

ARTICLE INFO

Article history:
Received 28 November 2017
Accepted 19 December 2017
Available online 26 December 2017

Keywords:
Ischemic stroke
Endovascular treatment
Mechanical thrombectomy eligibility
Systems of stroke care

ABSTRACT

Background and purpose: Mechanical thrombectomy (MT) is now well-established treatment method for selected patients with acute ischemic stroke (AIS) and efforts are being made to incorporate it into the systems of stroke care. Our objective is to assess the number of AIS individuals eligible for MT in the cohort of single academic stroke center.

Methods: We retrospectively reviewed initial non-invasive vascular imaging data of AIS patients presenting within 5 h of symptom onset for the presence of large vessel occlusion (LVO) over 2-year period (2015–2016). Among subjects confirmed with LVO: time-to-presentation, premorbid functional and on-admission neurological state, site of occlusion and initial imaging data were further assessed. Two sets of criteria based on recent trials and recommendations were used to determine MT eligibility. The onset-to-evaluation time limit was set to 5 h allowing ≤60 min procedure initiation delay.

Results: 895 patients with the final diagnosis of AIS were admitted to our stroke center as the initial treatment facility. 246 (27.5%) presented within 5 h of symptom onset and had non-invasive imaging performed. Among those 102 (41.5%) had causative LVO. The number of ≤5 h presenting patients eligible for MT was 51 (20.7%) when applying restrictive or 80 (32.5%) with more permissive criteria.

Conclusion: Among AIS patients, in whom onset-to-arrival time allowed to initiate the endovascular procedure within 6 h of symptom duration, 21% were eligible for MT treatment according to more and 33% to less restrictive criteria. It accounts for about 6% and 9% of all AIS cases, respectively.

* *Corresponding author at*: Kliniczny Szpital Wojewódzki Nr 2 im. Św. Jadwigi Królowej, ul. Lwowska 60, 35-301 Rzeszów, Poland.
E-mail address: wiacekmarcin@o2.pl (M. Wiącek).

Abbreviations: AIS, acute ischemic stroke; NIHSS, National Institutes of Health Stroke Scale; mRS, modified Rankin scale; EVT, endovascular treatment; MT, mechanical thrombectomy; LVO, large vessel occlusion; IVT, intravenous thrombolysis; RCTs, randomized controlled trials; ASPECTS, Alberta Stroke Program Early CT Score.

https://doi.org/10.1016/j.pjnns.2017.12.010
0028-3843/

1. Introduction

Large vessel occlusion (LVO), responsible for the significant portion of acute ischemic strokes (AIS) [1], is associated with low rates of recanalization and poor prognosis when treated medically [2]. Since 2015 several randomized clinical trials (RCTs) proving superiority of LVO treatment by mechanical thrombectomy (MT) were published [3]. These data have led to development of European Stroke Organization (ESO) consensus statement [4] and American Heart Association/American Stroke Association (AHA/ASA) guideline [5] that recommend MT as a first-line treatment method in a selected group of patients.

Recently, efforts are being made to implement endovascular AIS treatment into the health care systems worldwide. Developing regional stroke care network based on primary and comprehensive centers, with capability of the latter to perform MT, has been proposed [5]. In practice, organization of the AIS management relies on the predicted demands and cost-effectiveness analyses. Both require estimations of MT eligible patients.

Indifferently, the arrangement of national stroke care system that includes endovascular treatment facilities in Poland is debated. The purpose of our study is to determine the proportion of AIS patients suitable for MT to assist this process.

2. Materials and methods

2.1. *Study population*

Between January 2015 and December 2016 928 individuals with the final diagnosis of AIS were admitted to the single stroke center in Rzeszów (Poland) that is offering endovascular treatment [6]. 33 were transfers from other units (5 referred for MT) and were excluded from this study to obtain 895-patient cohort that had the opportunity to undergo entire reperfusion therapy qualification process in our department.

All subjects had initial non-contrast CT imaging and clinical evaluation by a neurologist. When eligible, intravenous thrombolysis (IVT) was administered ($n = 201$; 22.5%). According to in-hospital stroke protocol, every acute stroke patient within 5 h of symptom onset should have CT-angiogram performed during qualification for reperfusion therapy unless contraindications for iodine contrast administration (known allergy or renal failure). 189 (94%) out of 201 IVT-treated group had non-invasive vascular imaging performed. When LVO was confirmed, endovascular treatment (EVT) eligibility was further assessed by the endovascular treatment team (experienced neurologist and neuroradiologist).

For this study, we reviewed all AIS initial non-invasive vascular imaging data from the 2-year period (2015–2016) excluding subjects with onset-to-arrival time >5 h ($n = 47$). 246 (27.5%) individuals were identified in this manner. There was no emergent MR-angiography in the settings of AIS done.

2.2. *Clinical and imaging data*

The selected 246-patient group had their initial non-invasive vascular imaging assessed for the presence of treatable LVO [causative occlusion of intracranial internal carotid artery (ICA), the first (M1), second (M2) or third (M3) segment of middle cerebral artery (MCA), first (A1) or second (A2) portion of the anterior cerebral artery (ACA), dominant vertebral artery (VA), basilar artery (BA) and first (P1) segment of posterior cerebral artery]. The subjects with confirmed LVO had their records reviewed. Data on onset-to-presentation time, premorbid modified Rankin Scale (mRS), National Institutes of Health Stroke Scale (NIHSS) score on admission, site of vessel occlusion and on initial CT imaging were collected.

2.3. *Eligibility criteria*

We applied two sets of criteria derived from MT RCTs that were modified to fit clinical scenario. In both of them onset-to-presentation time was limited to 5 h to allow ≤60 min of in-hospital delay to initiate endovascular treatment. More restrictive criteria included subjects with MCA M1 and/or intracranial ICA occlusion with premorbid mRS ≤2, on-admission NIHSS ≥6 and initial CT ASPECT score of more than 5. The less stringent MT criteria encompassed cases of the broader range of causative LVOs (intracranial ICA, M1, M2 segments of MCA, A1 and A2 portions of ACA, BA and P1 segment of PCA), lower NIHSS threshold (≥3) and higher premorbid disability (mRS ≤3). The tandem occlusion of MCA and ICA was not regarded as MT contraindication in neither group.

2.4. *Statistical analysis*

The analysis was started by checking the normal distribution (Shapiro–Wilk test). Quantitative variables are presented by rate (%). Continuous variables are presented as mean ± SD (normal distribution) and as median with interquartile range (skewed distribution).

3. Results

In 246 cases onset-to-evaluation time allowed initiation of MT within 6 h of symptom onset and initial non-invasive vascular imaging was available. Among those we found 102 (41.5%) intracranial LVO. The localization of vessel occlusion and basic characteristics of the LVO-group are shown in the Tables 1 and 2, respectively.

According to predefined restrictive MT eligibility criteria, 75 subjects with M1 or terminal ICA closure were identified. Twenty-four of them were subsequently excluded because of: mild neurological deficit (NIHSS score <6) in 3, premorbid functional dependency (mRS>2) or unknown status in 11, extensive early ischemic changes on initial imaging (ASPECTS <6) in 4 and there was more than one cause in 6 cases (Fig. 1). With this approach we found 51 (20.7%) individuals to be eligible for endovascular treatment.

When applying less strict criteria, 97 patients with treatment-qualifying LVO (M1, M2, A1, A2, intracranial ICA, P1, BA) were determined. In this group, four subjects with extensive early ischemic changes on initial imaging (ASPECTS <6), 6 with mRS >3 or unknown, 2 with very mild baseline deficit (NIHSS <3) and other 5 with more than one exclusion

Table 1 – The localization of vessel occlusion.

Location (n = 102)	n (%)
Intracranial ICA	9 (8.8%)
M1	50 (49%)
M2	12 (11.8%)
M3	3 (2.9%)
A1	1 (1%)
A2	1 (1%)
BA	5 (4.9%)
P1	3 (2.9%)
VA	2 (2%)
Tandem ICA + MCA occlusion	16 (15.7%)

Abbreviations: ICA, internal carotid artery; MCA, middle cerebral artery; M1, first segment of middle cerebral artery; M2, second segment of middle cerebral artery; M3, third segment of middle cerebral artery; BA, basilar artery; P1, first segment of posterior cerebral artery; VA, vertebral artery.

Table 2 – Basic characteristics of the LVO cohort.

Variable	
Median age (IQR), years	79 (66–85)
Female sex, n (%)	62 (61%)
Median onset-to presentation time (IQR), min	77 (50–134)
Median NIHSS on-admission (IQR), points	15 (10–18)
Median baseline ASPECTSS (IQR), points	9 (8–10)
Intravenous thrombolysis (IVT) treatment, n (%)	77 (76%)

criteria were found. Hence, we identified 80 (32.5%) subjects potentially qualifying for MT with permissive algorithm.

4. Discussion

We found that around 40% of AIS individuals arriving within the EVT time window might have causative LVO. It is now proven that in this group MT is the most effective treatment method [4,5]. Employment of further MT inclusion criteria, however, leads to ruling out up to half of them. Our estimations show that, depending on qualification algorithm used, 21 or 33% are eventually eligible for thrombectomy. These results are consistent with the 26% given in the French regional registry study [7]. The other single-center analysis, assessing eligibility to each of seven recent EVT RCTs demonstrated rates widely ranging from 3 (THRACE [8]) to 53% (MR CLEAN [9]) [10]. The higher values provided are probably closer to real-world clinical practice, as the inclusion criteria tend to be more restrictive in most of the trials.

As shown, the MT-eligibility rates are highly dependent on the criteria used. The MCA and ICA occlusions are the only targets of clot retrieval with benefits of treatment unequivocally proven [11]. In our cohort, it accounted for three-quarter (n = 75/102) of causative LVOs. There is, however, some evidence from non-randomized studies that EVT of both M2 segment of MCA [12] and basilar artery [13,14] occlusions may result in high recanalization rates and good clinical outcomes. Our study demonstrates that considering MT in broader range of LVO cases (M2, A1, A2, BA, P1), could result in treating one more patient out of ten arriving within the treatment time widow (12%). There is recently no solid evidence to support this approach, but the clinical experience shows that it might be beneficial. Similarly, mild to moderate pre-stroke disability and low baseline NIHSS scores presumably should not be considered as an absolute contraindication to treatment, despite there is no clear data to confirm this statement [15].

Contrary to most of the other studies estimating MT eligibility [7,10,16], we set the limit of onset-to-evaluation time to 5 h to allow preparation of the procedure in 60 min. The optimization of in-hospital periprocedural organization would probably lead to more individuals treated. Employment of advanced imaging techniques might also affect the eligibility rates. Tissue viability assessment (CT perfusion, perfusion–diffusion MRI) improves patient selection as the infarct and penumbra sizes tend to correlate with functional outcomes [17]. It would decrease the eligibility of patients arriving within the given time limit, but some additional late-arriving individuals could be adequate for treatment based on penumbral size. There is currently insufficient high-quality evidence to recommend the routine usage of those imaging modalities in the qualification process.

According to our in-hospital stroke protocol, in the absence of contraindications, non-invasive vessel imaging within 5 h of AIS symptom onset is strongly recommended. The major weakness of our work is that we cannot accurately evaluate adherence to this point of protocol. We found that only 27.5% of all AIS patients (n = 246/895) underwent the examination in the given time frame. Based on our IVT treatment data, 94% (n = 189/201) of patients qualifying for intravenous thrombolysis had their CTA performed. It suggests that there was probably no substantial number of patients with the large vessel assessment omitted. Though, our results could be slightly overestimated due to possibility of excluding some subjects with low probability of being MT-eligible (e.g. with mild baseline deficit, high premorbid disability or extensive ischemic changes on initial CT) from such evaluation. It appears that the main reason for the small number of vessel imaging performed, was exceeding the EVT time window and not considering it as a treatment option. Hence, the significant amount of patients had lost their chances for effective reperfusion treatment due to pre-hospital delay. Reducing the onset-to-door time constitutes the primary point of potential improvement in the stroke care of our population. Efforts should be undertaken to solve this problem.

Since MT has become preferred treatment method for selected group of AIS patients, substantial re-organization of stroke care systems is much needed. Creating regional networks, comprising of primary and comprehensive AIS facilities is postulated [5]. The latter, with 24/7 access to EVT, should serve adequate population within a reasonable time range [4,18]. Therefore, data on eligibility and cost-effectiveness of MT are essential to provide basis for system planning [19]. Recent Australian population-based study predicted that 7 or 13% of all AIS patients may be candidates for EVT, depending on criteria restrictiveness [16]. It translated into ≤22 per 100 000 person-years. Similar estimations (11–22 per 100 000) were presented by Rai and colleagues within US population [20]. Our work is not a population-based study and the AIS cohort is not well-characterized, but with similar criteria applied, the eligibility rates could be roughly

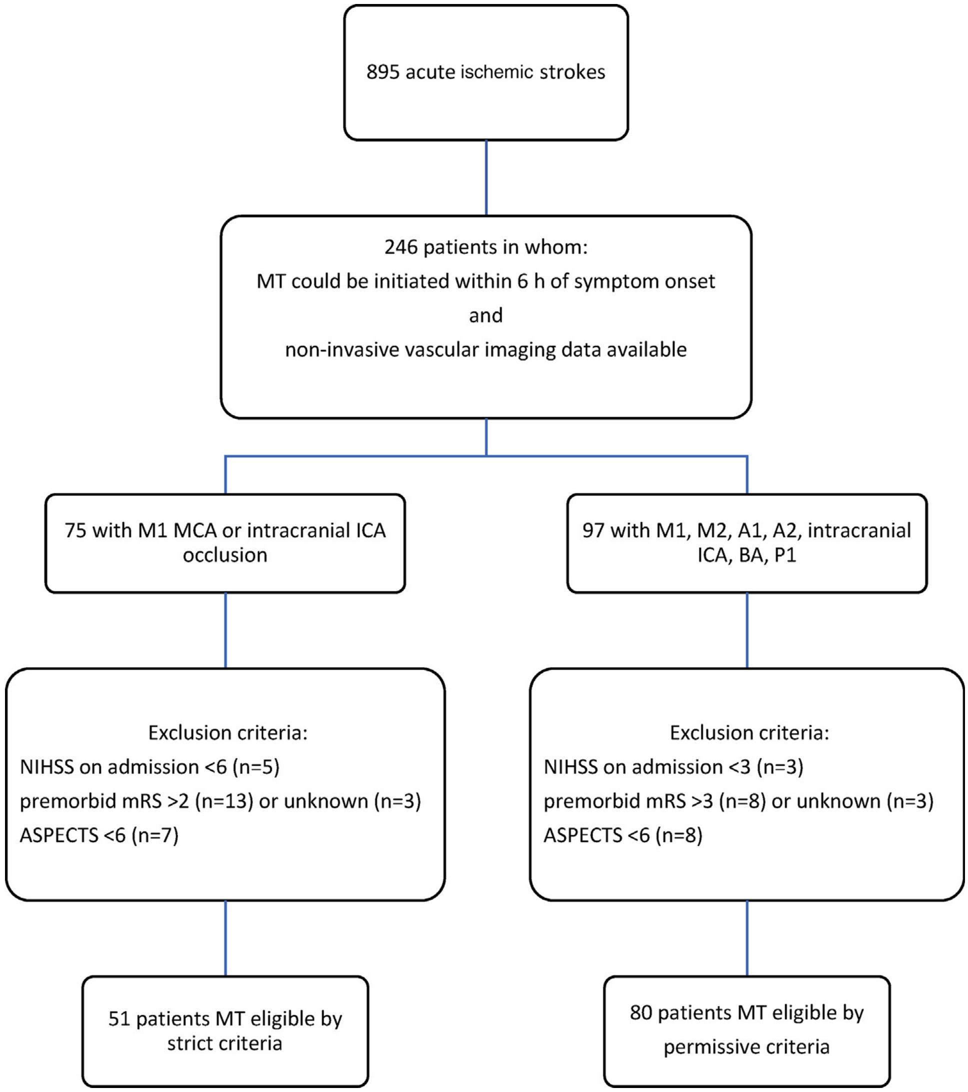

Fig. 1 – Acute ischemic stroke patients eligible for mechanical thrombectomy (MT) with application of two prespecified qualification algorithms. Each patient could meet more than one exclusion criterion. *Abbreviations*: AIS, acute ischemic stroke; ICA, internal carotid artery; MCA, middle cerebral artery; M1, first segment of middle cerebral artery; M2, second segment of middle cerebral artery; BA, basilar artery; P1, first segment of posterior cerebral artery; NIHSS, National Institutes of Health Stroke Scale; mRS, modified Rankin score; ASPECTS, Alberta Stroke Program Early CT Score.

estimated to be 6 or 9%. These values are comparable with abovementioned analyses, which suggests that provided data could be cautiously used for stroke care system planning in Poland.

5. Conclusion

We found that, depending on inclusion criteria used, 21 or 33% of our AIS patients, whose onset-to-evaluation time allows to initiate mechanical thrombectomy within 6 h, could be eligible for treatment. It translates into about 6 and 9% of all AIS, respectively. It shows that substantial number of individuals is potential candidates for endovascular treatment and efforts should be made to achieve comparable rates in real life.

Conflict of interest

None declared.

Acknowledgement and financial support

None declared.

REFERENCES

[1] Smith WS, Lev MH, English JD, Camargo EC, Chou M, Johnston SC, et al. Significance of large vessel intracranial

occlusion causing acute ischemic stroke and TIA. Stroke 2009;40:3834–40. http://dx.doi.org/10.1161/STROKEAHA.109.561787
[2] Bhatia R, Hill MD, Shobha N, Menon B, Bal S, Kochar P, et al. Low rates of acute recanalization with intravenous recombinant tissue plasminogen activator in ischemic stroke. Stroke 2010;41:2254–8. http://dx.doi.org/10.1161/STROKEAHA.110.592535
[3] Balami JS, Sutherland BA, Edmunds LD, Grunwald IQ, Neuhaus AA, Hadley G, et al. A systematic review and meta-analysis of randomized controlled trials of endovascular thrombectomy compared with best medical treatment for acute ischemic stroke. Int J Stroke 2015;10:1168–78. http://dx.doi.org/10.1111/ijs.12618
[4] Wahlgren N, Moreira T, Michel P, Steiner T, Jansen O, Cognard C, et al. Mechanical thrombectomy in acute ischemic stroke: consensus statement by ESO-Karolinska Stroke Update 2014/2015, supported by ESO, ESMINT, ESNR and EAN. Int J Stroke 2016;11:134–47. http://dx.doi.org/10.1177/1747493015609778
[5] Powers WJ, Derdeyn CP, Biller J, Coffey CS, Hoh BL, Jauch EC, et al. 2015 AHA/ASA focused update of the 2013 guidelines for the early management of patients with acute ischemic stroke regarding endovascular treatment; 2015. http://dx.doi.org/10.1161/STR.0000000000000074
[6] Wiacek M, Kaczorowski R, Homa J, Filip E, Darocha J, Dudek D, et al. Single-center experience of stent retriever thrombectomy in acute ischemic stroke. Neurol Neurochir Pol 2017;51:12–8. http://dx.doi.org/10.1016/j.pjnns.2016.09.001
[7] Papassin J, Favre-Wiki IM, Atroun T, Tahon F, Boubagra K, Radier G, et al. Patient eligibility for thrombectomy after acute stroke: Northern French Alps database analysis. Rev Neurol Paris 2017;173:216–21. http://dx.doi.org/10.1016/j.neurol.2017.03.010
[8] Bracard S, Ducrocq X, Mas JL, Soudant M, Oppenheim C, Moulin T, et al. Mechanical thrombectomy after intravenous alteplase versus alteplase alone after stroke (THRACE): a randomised controlled trial. Lancet Neurol 2016;15:1138–47. http://dx.doi.org/10.1016/S1474-4422(16)30177-6
[9] Berkhemer OA, Fransen PSS, Beumer D, van den Berg LA, Lingsma HF, Yoo AJ, et al. A randomized trial of intraarterial treatment for acute ischemic stroke. N Engl J Med 2014;372. http://dx.doi.org/10.1056/NEJMoa1411587. 141217070022009
[10] Tawil ES, Cheripelli B, Huang X, Moreton F, Klladka D, MacDougal NJJ, et al. How many stroke patients might be eligible for mechanical thrombectomy? Eur Stroke J 2016;1:264–71. http://dx.doi.org/10.1177/2396987316667176
[11] Evans MRB, White P, Cowley P, Werring DJ. Revolution in acute ischaemic stroke care: a practical guide to mechanical thrombectomy. Pract Neurol 2017;17:252–65. http://dx.doi.org/10.1136/practneurol-2017-001685
[12] Chen CJ, Wang C, Buell TJ, Ding D, Raper DM, Ironside N, et al. Endovascular mechanical thrombectomy for acute middle cerebral artery M2 segment occlusion: a systematic review. World Neurosurg 2017;107:684–91. http://dx.doi.org/10.1016/j.wneu.2017.08.108
[13] Baek JM, Yoon W, Kim SK, Jung MY, Park MS, Kim JT, et al. Acute basilar artery occlusion: outcome of mechanical thrombectomy with solitaire stent within 8 hours of stroke onset. Am J Neuroradiol 2014;39:989–93. http://dx.doi.org/10.3174/ajnr.A3813
[14] Uno J, Kameda K, Otsuji R, Ren N, Nagaoka S, Maeda K, et al. Mechanical thrombectomy for acute basilar artery occlusion in early therapeutic time window. Cerebrovasc Dis 2017;44:217–24. http://dx.doi.org/10.1159/000479939
[15] Haussen DC, Bouslama M, Grossberg JA, Anderson A, Belagage S, Frankel M, et al. Too good to intervene? Thrombectomy for large vessel occlusion strokes with minimal symptoms: an intention-to-treat analysis. J Neurointerv Surg 2017;9:917–21. http://dx.doi.org/10.1136/neurintsurg-2016-012633
[16] Chia NH, Leyden JM, Newbury J, Jannes J, Kleinig TJ. Determining the number of ischemic strokes potentially eligible for endovascular thrombectomy: a population-based study. Stroke 2016;47:1377–80. http://dx.doi.org/10.1161/STROKEAHA.116.013165
[17] Zhu G, Michel P, Aghaebrahim A, Patrie JT, Xin W, Eskandari A. Computed tomography workup of patients suspected of acute ischemic stroke: perfusion computed tomography adds value compared with clinical evaluation, noncontrast computed tomography, and computed tomography angiogram in terms of predicting outcome. Stroke 2013;44:1049–55. http://dx.doi.org/10.1161/STROKEAHA.111.674705
[18] Daubail B, Ricolfi F, Thouant P, Vogue C, Chavent A, Osseby GV, et al. Impact of mechanical thrombectomy on the organization of the management of acute ischemic stroke. Eur Neurol 2016;75:41–7. http://dx.doi.org/10.1159/000443638
[19] Achit H, Soudant M, Hosseini K, Bannay A, Epstein J, Bracard S, et al. Cost-effectiveness of thrombectomy in patients with acute ischemic stroke. Stroke 2017;48:2843–7. http://dx.doi.org/10.1161/STROKEAHA.117.017856
[20] Rai AT, Seldon AE, Boo SH, Link PS, Domico JR, Tarabishy AR, et al. A population-based incidence of acute large vessel occlusions and thrombectomy eligible patients indicates significant potential for growth of endovascular stroke therapy in the USA. Neurointervent Surg 2017;9:722–6. http://dx.doi.org/10.1136/neurointsurg-2016-012515