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Primary aspiration thrombectomy for posterior circulation stroke

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ABSTRACT

Purpose: Primary aspiration thrombectomy reports on posterior circulation stroke (PCS) are still rare. Therefore, we aimed to investigate the effectiveness and safety of aspiration as a first-line approach.

Material and Methods: All patients that received thrombectomy for acute ischaemic stroke with the primary aspiration technique for PCS between 07/2015-12/2018 were retrospectively analysed (n=50). In some cases stent retriever devices were used secondarily. Statistical analysis was performed to identify predictors for early favourable functional outcome (modified Rankin Scale-mRS≤2) and differences between successful aspiration and secondary stent retriever use. Procedural outcomes and safety were evaluated with reference to the thrombolysis in cerebral infarction (TICI) scale, time to recanalisation, rates of symptomatic intracerebral haemorrhage (sICH), and severe adverse events related to the intervention.

Results: Primary aspiration was performed successfully in 66% (33/50) of cases. In 17 of 50 cases (34%) stent retriever devices were used secondarily. Successful recanalisation (TICI ≥2b) was achieved in 94% (46/50) of cases. An overall early favourable functional outcome was observed in 38% (19/50) of patients at discharge (mRS≤2). Compared to the secondary stent retriever group, the aspiration group showed significantly higher rates of functional outcome (45.5% vs. 23.5%, respectively) and successful recanalisation (TICI≥2b; 100% vs. 82.4%); a lower rate of in-hospital mortality (24% vs. 41.2%); and a faster median recanalisation time (40.5 min vs. 63 min).

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Conclusions: If successful, primary aspiration thrombectomy for PCS can achieve high rates of early favourable functional outcome and successful recanalisation with short procedural times. Further investigation is needed to determine whether stent retriever and aspiration mechanical thrombectomy are equally effective methods, and to understand why aspiration fails in some PCS cases.

KEY WORDS | Ischaemic stroke; Posterior circulation; Aspiration thrombectomy

Introduction

Stroke is one of the most common reasons for disability, dementia and death worldwide [1]. Approximately 20-25% of all strokes appear within the posterior circulation (PC). Large vessel occlusion strokes within the PC are rare and represent only 1% of all ischaemic strokes and 5% of all large vessel occlusions [2]. Moreover, these occlusions in the PC are known to carry a higher risk of mortality and poorer outcome compared to anterior circulation stroke (ACS) despite the best medical treatment including endovascular therapy [3, 4]. Thus, complete recanalisation of the occluded vessel is crucial in the therapy of posterior circulation stroke (PCS) in order to potentially prevent patient death or life-long neurological disability [5].

Randomised trials have demonstrated the benefits of mechanical thrombectomy (MT) in the treatment of acute ischaemic stroke [6, 7]. Primary aspiration thrombectomy has proved to be equally effective as stent retrievers with high rates of successful recanalisation and favourable functional outcomes [8]. Nevertheless, to date all randomised MT studies that have focused on stroke within the anterior circulation have excluded patients with PCS [6]. Therefore, only retrospective case studies on patients receiving MT for PCS have been published so far. We report on our experience using the primary aspiration technique as a first-line approach for PCS.

Material and Methods

Patient population

Between July 2015 and December 2018, 600 patients with an acute ischaemic stroke were treated endovascularly. We retrospectively analysed all cases and found 78 patients (13%; 78/600) with PCS. A total of 50 patients (8.3%; 50/600) were treated with primary aspiration thrombectomy and were ultimately included in the study **(Fig. 1)**. Due to variations in commercial availability over the years, different aspiration catheters were used in the selected cases including the Penumbra ACE, ACE64, and ACE68 (Penumbra Inc., Alameda, California, USA). In cases of posterior circulation occlusions, all eligible patients were treated with intravenous thrombolysis (IVT) prior to MT. MT was performed in the Neurointerventional Unit under consensus sedation. General anaesthesia and intubation were only performed for uncooperative and/or agitated patients.

Procedural and functional outcome

Experienced Neurologists assessed neurological outcome using the National Health Institute Stroke Scale (NIHSS) and modified Rankin Scale (mRS) on hospital admission and discharge. Early functional outcome was considered as favourable in the range of mRS≤2 **(Fig. 2)**. The angiographic outcome was evaluated at the end of the procedure based on the thrombolysis in cerebral infarction (TICI) score defining successful recanalisation as TICI≥2b **(Figs. 3, 4)**. Further outcome measures included the time from groin-puncture to recanalisation, in-hospital mortality, and serious adverse events (SAE) which included symptomatic intracerebral haemorrhage (sICH; defined according to ECASS II as worsening of a patient's neurological status of more than 4 on the NIHSS scales within 24 h) and distal embolisation [9].

Statistical methods

Standard descriptive statistics were employed for all study endpoints. Kolmogorov–Smirnov tests were used to determine whether the data set was normally distrib-

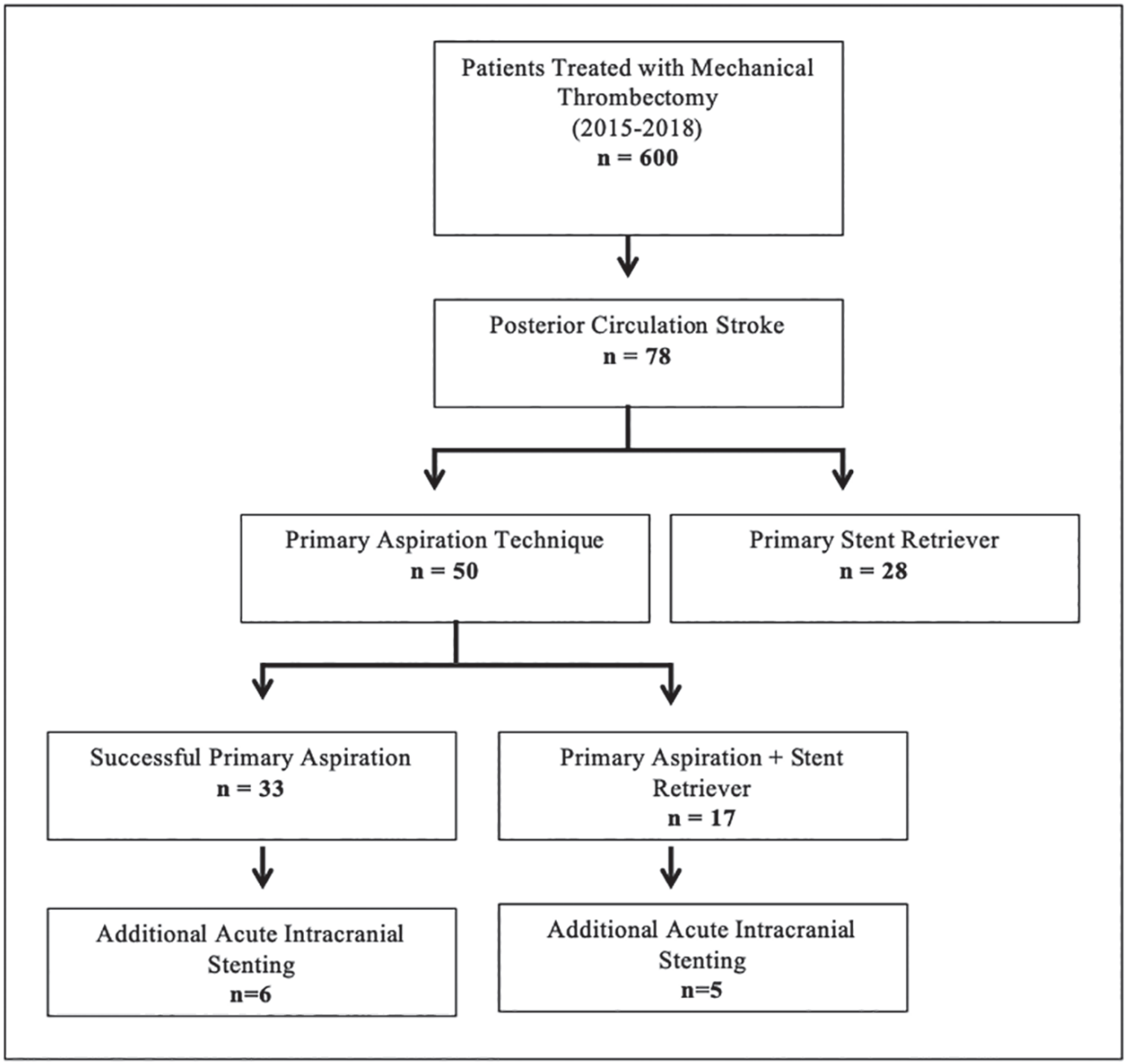

Fig 1. *Flow chart of the study protocol for patient inclusion.*

uted or not. Univariable distribution of metric variables was described by median and interquartile range (IQR). The Mann–Whitney U test, χ^2 test or Fisher's exact test were performed to compare two independent samples on a metric or categorical outcome. Logistic regression analysis was performed to identify predictors for early favourable functional outcomes at discharge. Results are presented as odds ratios (ORs) with 95% confidence interval (CI). The significance level was set at α=0.05. All statistical analyses were carried out using SPSS Version 22 (SPSS, Chicago, Illinois, USA).

Results

Baseline characteristics

Overall 50 out of 600 endovascularly treated patients with acute ischaemic stroke fulfilled the main inclusion criteria of 1) intracranial large vessel occlusions within the posterior circulation, and 2) primary aspiration thrombectomy as first choice for endovascular treatment. Median age was 73 (IQR 57-78) and 40% (20/50) were women. On hospital admission the median NIHSS score was 12.5 (7-20). Prior to MT, 32% (16/50) of the patients received an additional intravascular thrombolysis

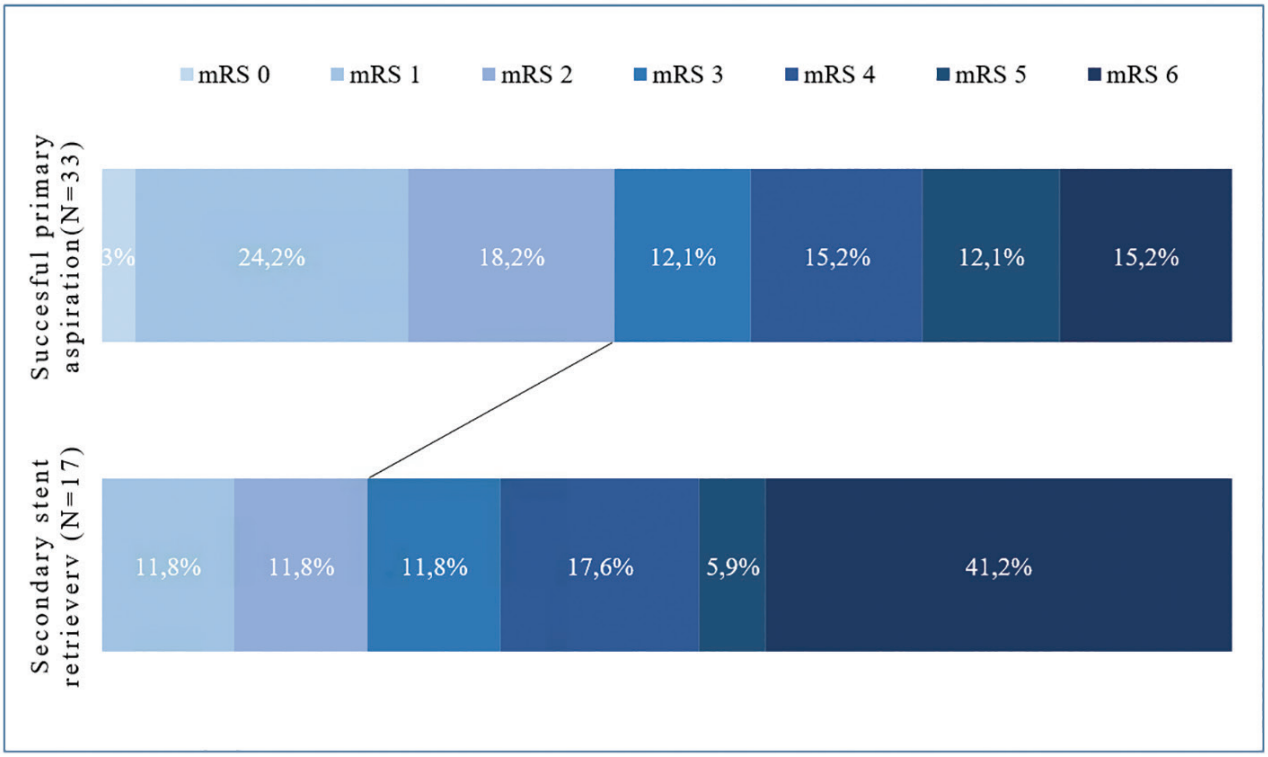

Fig. 2. *Distribution of modified Rankin scores (mRS) at discharge compared by cases with successful primary aspiration and secondary stent retriever utilisation (the black line shows shift of early favourable outcome defined as mRS≤2 between both groups).*

(IVT). All occlusions were located within the PC: 20% (10/50) vertebral artery (VA); 66% (33/50) basilar artery (BA); and 14% (7/50) proximal P1 segment of posterior cerebral artery (PCA) with basilar tip affection. Furthermore, 11 patients were treated additionally with acute intracranial stenting (ICS) after MT due to a suspected underlying stenosis. An overview of the baseline characteristics of the patient population is shown in **Table 1**.

Procedural outcome

MT was performed under general anaesthesia in 62% (31/50) of all cases. In 66% (33/50) of cases the primary aspiration technique was successfully performed alone. In the rest of the cases (34%; 17/50) a secondary stent retriever was needed due to either partial/no recanalisation or distal embolisation. A successful recanalisation was defined as TICI≥2b and was achieved in 94% (47/50) of the study population. A TICI≥2b was noted in all cases in which the primary aspiration was successful. If primary aspiration was successful then recanalisation rates of TICI≥2b (100% vs. 82.4%) were significantly higher and thrombectomy itself had a faster groin-puncture to recanalisation median time (40.5 min vs. 63 min; **Table 2**).

In 22% (11/50) of cases additional ICS was performed due to potential intracranial atherosclerotic disease causing high-grade stenosis, which was a potential risk for early re-occlusion. There was no significant association of ICS with successful primary aspiration or the use of an additional stent retriever. Further, there was no occurrence of SAEs related to the intervention as well as sICH.

Functional outcome

An early favourable functional outcome (mRS≤2) was seen in a total of 38% (19/50) of patients at discharge (**Fig. 2**). The total rate of in-hospital mortality was 24% (12/50). There were no complications such as sICH or iatrogenic dissections. In the successful primary aspiration group, 45.5% (15/33) of the patients achieved an mRS≤2 at discharge and mortality was 15.2% (5/33). There were no significant differences in baseline characteristics between the primary aspiration and additional stent retriever groups. Logistic regression analysis identified lower NIHSS scores on admission as a significant predic-

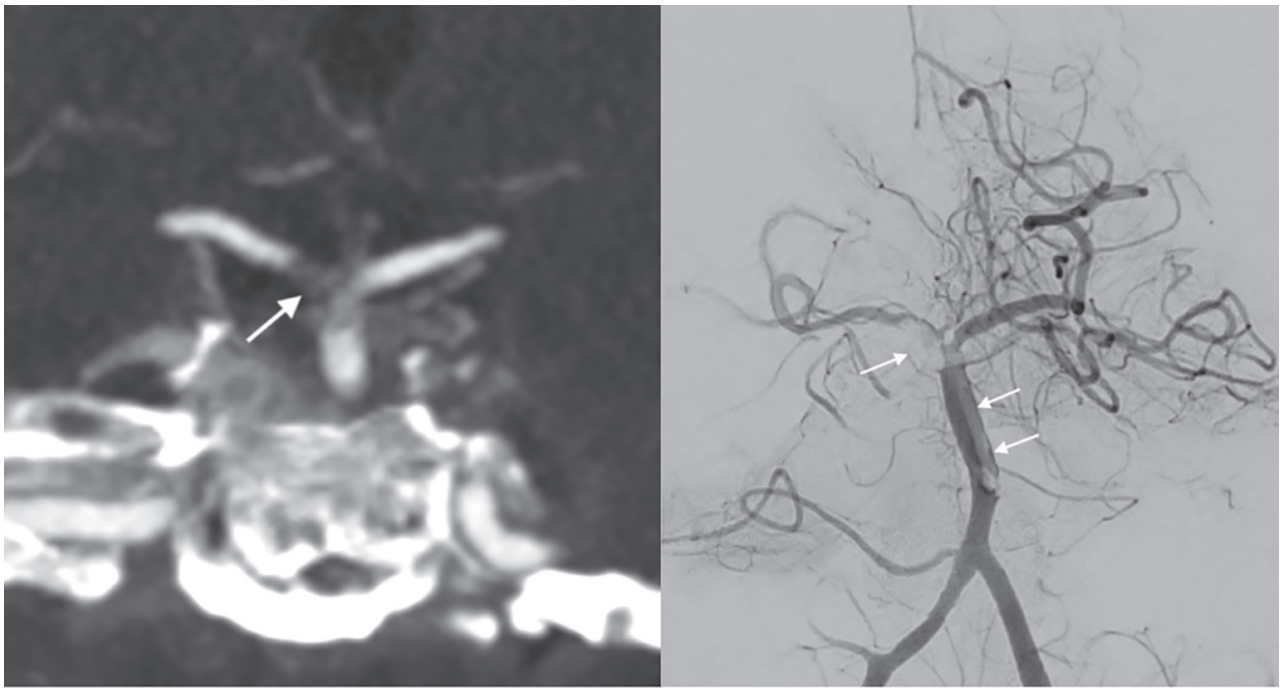

Fig. 3. *Computed tomography angiography (CTA) on the left shows an acute occlusion of the basilar artery and the proximal posterior cerebral artery (white arrow). Digitial substraction angiography (DSA) on the right shows the whole length of the thrombus extending from the basilar artery (white arrows on the right) into the proximal P1 segment (white arrow on the left).*

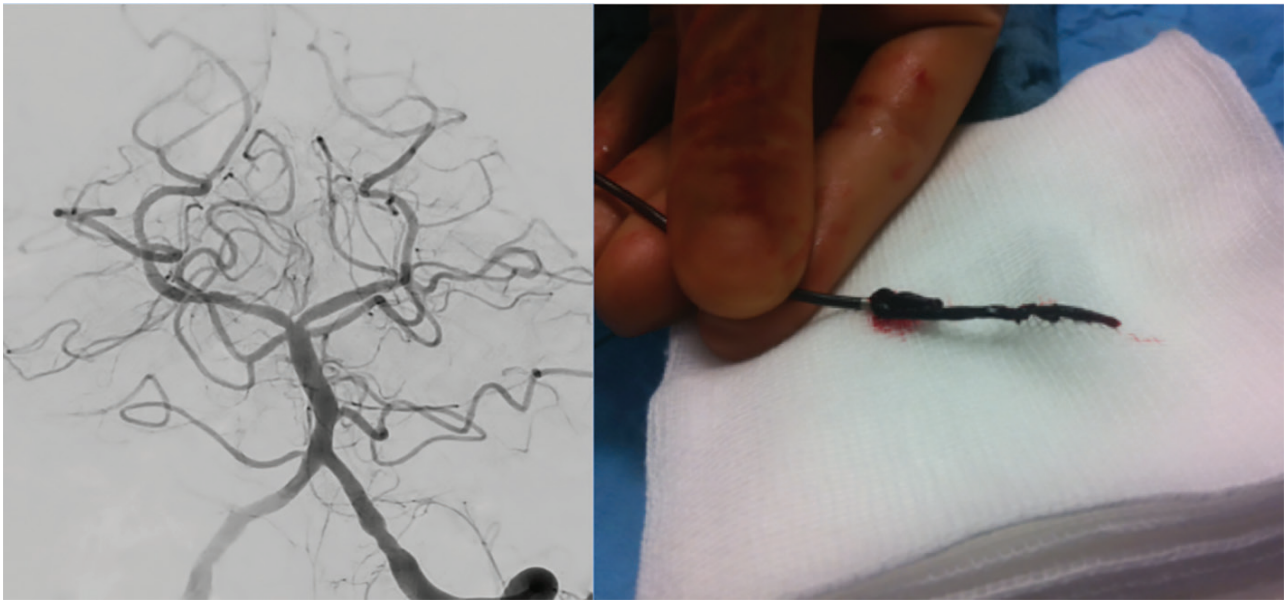

Fig. 4. *Digital substraction angiography (DSA) on the left shows successful primary aspiration thrombectomy with complete recanlisation of the occluded vessel and the extracted thrombus in one piece on the right.*

tor for early favourable functional outcome at discharge (mRS≤2; OR 1.22; 95% CI 1.07 to 1.39; p=0.002). If primary aspiration was not successful then 23.5% (4/17) of the patients achieved an early favourable functional outcome **(Fig. 2)**. Direct comparison of both groups showed significantly higher rates of functional outcome (45.5% vs. 23.5%) and lower rates of in-hospital mortality (24% vs. 41.2%) in the successful aspiration group **(Table 2)**.

Table 1. Baseline characteristics of the study population

Characteristics	*All Patients (n=50)*	*Successful Primary Aspiration (n=33)*	*Additional Stent Retriever (n=17)*	*p-value*[1]
Median Age (IQR)	73 (57-78)	74 (61-78)	72 (54-78)	0.467
Women (%(n))	40 (20/50)	39.4 (13/33)	41.2 (7/17)	0.903
Median NIHSS (IQR)	12.5 (7-20)	13 (7-20)	12.5 (8.5-20)	0.908
Median mRS (IQR)	5 (3-5)	4 (3-5)	5 (4-5)	0.208
Site of Occlusion (%(n))				
- VA - BA - PCA	20 (10/50) 66 (33/50) 14 (7/50)	18.2 (6/33) 66.7 (22/33) 15.2 (5/33)	23.5 (4/17) 64.7 (11/17) 11.8 (2/17)	0.719[3]
Site of ICS (%(n))				
- VA - BA	82 (9/11) 18 (2/11)	83 (5/6) 17 (1/6)	80 (4/5) 20 (1/5)	
IVT[2] *(%(n))*	32 (16/50)	39.4 (13/33)	17.6 (3/17)	0.200
Thrombectomy Method (%(n))				
- Primary Aspiration - Secondary Stent Retriever	66 (33/50) 34 (17/50)	- -	- -	

[1] *Comparing groups of successful aspiration vs. stent retriever;* [2]*IVT= intravenous thrombolysis,* [3] *Comparing VA vs. BA*

Discussion

Aspiration thrombectomy, first proven in 2017 and confirmed by several randomised trials, is considered to be a first-line approach for ACS [8, 10, 11]. Accordingly, we found our initial experience with the primary aspiration technique in line with these studies [12]. However, reports on MT for PCS are still rare, especially on primary aspiration thrombectomy. This study aimed to investigate the effectiveness and safety of primary aspiration as a first-line approach for PCS.

Previous retrospective studies focusing on aspiration thrombectomy for PCS found successful recanalisation rates (TICI≥2b) ranging from 83% to 94% and favourable functional outcome (mRS≤2) rates from 33% to 43% at 90-day follow-up [13-16]. With successful recanalisation rates (TICI≥2b) of 94% (47/50) and early favourable functional outcomes (mRS≤2) of 38% (19/50) at discharge, our results were similar to the mentioned studies as well as to the ENDOSTROKE study on MT for BA occlusions [4]. Even though discharge and 90-day follow-up outcome rates are not directly comparable, mRS discharge is known to be a good surrogate for 90-day outcome [17]. In a retrospective analysis Gory et al. observed a 44% mortality rate (42/95) at 90-days that did not differ significantly with regard to the choice of the first-line MT approach (aspiration vs. stent retriever) [13]. In this study, however, mortality at discharge was lower (24% or 12/50). Compared to this result, Kang et al. reported an even lower mortality rate of 16.4% (11/67) after aspiration MT at 90-day follow-up [14].

In our study the number of successful primary aspirations exceeded those of cases with additional need of secondary stent retriever marking vessel occlusions that were obviously more complicated to recanalise for

Table 2. Procedural and outcome differences differences compared by groups of successful aspiration and secondary stent retriever utilisation

	Successful Primary Aspiration (n=33)	*Secondary Stent Retriever (n=17)*	*p-value*
TICI≥2b % (n)	100 (33/33)	82.4 (14/17)	**0.034**
Median groin-puncture to recanalisation time, min (IQR)	35 (26-56)	63 (43.5-80)	**0.01**
Median mRS at discharge (IQR)	3 (1-5)	4 (2.5-6)	**0.057**
In-Hospital Mortality % (n)	15.2 (5/33)	41.2 (7/17)	**0.041**

primary aspiration. On the contrary, results were excellent in all cases with successful primary aspiration with recanalisation rates of 100% (TICI≥2b; 33/33), early favourable functional outcomes in 45.5% of cases (15/33) and a short median procedural time of 40.5 min. These findings emphasise the effectiveness of successful aspiration thrombectomy. In all cases of unsuccessful primary aspiration (no or partial recanalisation), stent retriever were used secondarily. It remains unclear why some thrombi are refractory to aspiration in the PC. However, this problem has been reported previously for primary aspiration and vice versa for primary stent retriever thrombectomy [18]. Additionally, aspiration MT is known to be a more demanding method compared to stent retriever MT, especially for neurointerventional beginners [19]. Therefore, a potential cause for some failed aspiration cases could be the inhomogeneous delivery of aspiration MT by neurointerventionalists working within one department. In 11 cases additional ICS was performed after MT due to a suspected underlying atherosclerotic stenosis, wall-adherent calcified thrombi, or dissection causing insufficient or unsustainable recanalisation. Lately, it has been shown that acute ICS can provide sustainable recanalisation in these situations and prevent stroke recurrence [20]. These cases are more complicated to recanalise and are known to carry a higher risk for reperfusion bleeding due to the necessity of periprocedural antithrombotic therapy that comes along with permanent stent implementation [21]. Therefore, these cases could represent a bias in our analysis. However, there was neither a significant distribution of these cases in either group (successful aspiration and secondary stent retriever), nor an association towards increased complications or poor outcome. Thus, ICS seems to be an effective and safe rescue therapy for PCS as previously reported [14].

In logistic regression analysis lower NIHSS scores on admission were significantly associated with favourable outcome at discharge. Even though it is known that the NIHSS is not the most representative scale for grading PCS, this result was consistent with previous findings demonstrating that the stroke severity on admission partially determines final rates of good outcome [22-24]. In line with the results of Kang et al. we did not observe any sICH after primary aspiration thrombectomy demonstrating the possible safety of this particular thrombectomy method [14].

Limitations

Our study contains all the limitations that are associated with a retrospective study design. Additionally, the interpretation of the results is limited due to missing data on the 90-day follow-up for long-term outcome evaluation. Moreover, the TICI scale for evaluating recanalisation was initially not designed for the PC and might be associated with a poor inter-rater agreement; however most studies on PCS depend on the TICI scale [25].

Conclusion

Based on our study we found aspiration thrombectomy to be a safe and effective first-line approach for PCS and this procedure led to high rates of early favourable functional outcomes at discharge. In comparison to the latest evidence on MT using either aspiration, stent retriever,

or both for ACS, we did not see any disadvantages using primary aspiration thrombectomy for PCS. However, if primary aspiration succeeds, then high rates of favourable outcome and successful recanalisation in a short procedure time can be expected. More clinical evidence is needed to investigate whether stent retriever and aspiration catheter thrombectomy are equally benefical for stroke within the PC compared to ACS despite anatomical differences, and to determine the potential disadvantages of the aspiration technique in PCS. **R**

Conflict of ineterst

P. Papanagiotou: Local Pi swift prime study (Medtronic Inc.), Consultancy Penumbra Inc. Johnson & Johnson, PhenoxInc.

C. Roth: Consultancy Penumbra Inc., Phenox Inc.

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