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Original research

Stent retriever versus aspiration based thrombectomy: impact on first pass reperfusion, procedure time, and clinical outcomes in large vessel occlusion. Nationwide registry based cohort study

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ABSTRACT

Background First pass reperfusion (FPR), defined as near complete reperfusion (extended Treatment in Cerebral Ischemia (eTICI) score 2c/3) in a single attempt without rescue therapy has been proposed as a quality metric. However, it remains unclear if the thrombectomy method influences clinical outcome and FPR rate. This study evaluates whether stent retriever and aspiration based thrombectomy differ in FPR rate, technical and clinical outcomes in FPR, and multiple pass reperfusion (MPR).

Methods This retrospective, nationwide, multicenter registry study included consecutive patients with proximal anterior or posterior circulation stroke, treated between 2018 and 2021 in Sweden. Outcome measures were FPR rate, procedure time, early neurological improvement (≥4 points on National Institutes of Health Stroke Scale (NIHSS) or a score of 0–1 at 24 hours), favorable functional outcome (modified Rankin Scale score of 0–2 or no decline at 90 days), and mortality at 90 days.

Results Of 3309 patients (median age 75, median NIHSS 16), 1990 underwent stent retriever and 1319 aspiration based thrombectomy as the firstline method. No difference in FPR rate was observed. Aspiration based thrombectomy showed a shorter procedure time in the FPR group (crude OR (cOR) 6.4 min (95% CI 3.4 to 9.3), adjusted OR (aOR) 8.7 min (95% CI 1.8 to 15.6)) and MPR group (cOR 9.7 min (95% CI 4.0 to 15.4), aOR 17.4 min (95% CI 9.6 to 25.2)), and association with early neurological improvement (cOR 1.21 (95% CI 1.03 to 1.42), aOR 1.40 (95% CI 1.18 to 1.67)) and favorable functional outcome (aOR 1.22 (95% CI 1.01 to 1.47)).

Conclusions Our findings suggest that aspiration based thrombectomy was associated with a shorter procedure time and better clinical outcomes than treatment with a stent retriever. No difference was found in FPR rate.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Early randomized controlled trials showed non-inferiority of aspiration based thrombectomy compared with stent retriever, but register based observatory studies have shown mixed results.
⇒ Previous studies reflected data from an earlier time period, which might not be relevant today as thrombectomy devices and strategy have undergone substantial development.
⇒ Difference in first pass reperfusion is not known between these methods.

WHAT THIS STUDY ADDS

⇒ This large registry based national study in patients treated from 2018 to 2021 suggested the potential benefit of aspiration based thrombectomy compared with stent retriever, both in shorter procedural time and improved clinical outcome.
⇒ No difference in first pass reperfusion rate was found.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ We suggest that results from previous studies might need to be re-evaluated because substantial developments in both device technology and strategy have taken place.
⇒ The results of this study, taken together with the significantly lower procedural cost of aspiration based thrombectomy, could influence policy and operator decision making in method selection of endovascular thrombectomy.

INTRODUCTION

Despite technically successful reperfusion, stroke patients with large artery occlusions show considerable variability in clinical outcomes. To enhance the efficacy of thrombectomy procedures, Zaidat *et al*[1] proposed a technical quality metric, known as first pass reperfusion (FPR). FPR is defined as the achievement of successful reperfusion, extended Treatment in Cerebral Ischemia (eTICI) score 2c or 3, after the initial passage of the thrombus, without the use of rescue therapy (eg, intra-arterial thrombolytics) or permanent intracranial stent placement. Early investigations have demonstrated a strong correlation between FPR and functional independence, improved neurological outcome, and reduced mortality rates compared with multiple pass reperfusion (MPR), defined as eTICI 2c or 3 with multiple passes and/or the use of intra-arterial thrombolysis.[2]

Recent randomized studies have suggested that stent retriever and aspiration based thrombectomy perform similarly regarding the FPR rate while other observational studies have shown differences.[3–6] Further, there is no consensus on whether the methods differ in technical and clinical outcomes when FPR or MPR is achieved.[5] Experience of the operator might predict FPR, and the learning curve of the methods might differ, indicating that high volume center analysis is needed to compare true effects.[7 8] In addition, the location of occlusion might be important because a recent study showed differences in functional outcome at 90 days favoring aspiration based thrombectomy in posterior circulation stroke.[9]

The aim of this study was to assess whether the choice of thrombectomy method influences the FPR rate and whether procedure time and clinical outcomes differ for the FPR and MPR groups based on the firstline method. We further conducted sensitivity analyses of high volume centers, anterior and posterior stroke, and propensity score matched analyses to better explore the robustness of our findings.

METHODS

Study design and data sources

In this retrospective, nationwide, register based clinical cohort study, data from consecutive adult patients with large vessel occlusion (LVO) and treated with endovascular therapy (EVT) at six university hospitals in Sweden between January 2018 and December 2021 were extracted from a registry which pools data from the national stroke registry (Riksstroke, https://www.riksstroke.org/eng/) and the national endovascular thrombectomy registry (EVAS, https://evas-registret.se/). All patients aged ≥18 years with information on thrombectomy method available were included. Patients without information on the number of attempts or grade of reperfusion were excluded because this is a requisite for assessment of FPR. Patients with multiple occlusions were excluded as this inherently made FPR unreachable. Patients with occlusions at vessel locations where equal feasibility of aspiration based thrombectomy and stent retriever could not be guaranteed (M3, P2, and A1) were excluded.

Endovascular treatment and definition of treatment groups

Patients were eligible for EVT if they presented with clinical symptoms of anterior or posterior ischemic stroke, with LVO confirmed by CT angiography on arrival at the hospital, and if treatment could be offered within 24 hours from stroke onset. All patients without contraindications and arrival at the hospital within 4.5 hours of stroke onset received intravenous thrombolysis. Reperfusion was estimated and graded at the final DSA by the neurointerventionist according to the eTICI score.

Treatment method group (aspiration based thrombectomy or stent retriever) was assigned according to the firstline method without consideration of eventual change in later attempts. Due to differences in reporting nationally, we classified stent retriever with and without the additional use of a proximal aspiration catheter (combined technique) as stent retriever. When a stent retriever was used, FPR was defined as eTICI 2c or 3 after first passage of the thrombus with the microcatheter. When aspiration based thrombectomy was used, first passage was considered if the aspiration catheter maintained continuous contact with the thrombus.

MPR was defined as eTICI 2c or 3 after multiple passages of the thrombus, or eTICI 2c or 3 with the use of rescue therapy after the first passage. Non-excellent reperfusion (NER) was defined as eTICI 0–2b at the end of the procedure. Collateral perfusion was graded by the operator on initial DSA as good (retrograde collateral reconstitution of the major branches down to the level of occlusion), moderate (rapid collaterals in the periphery of the ischemic site but slow and partial collateral reconstitution of major branches distal to the occlusion), poor (collaterals only to the periphery of the ischemic site), zero (no collaterals visible to the ischemic site), or not judgable.

Outcome measures

Technical outcome measures were FPR rate and procedure time, defined as the time from groin puncture to final result or abortion of the procedure. Clinical outcome measures were early neurological improvement (ENI), defined as improvement in National Institutes of Health Stroke Scale (NIHSS) score of >4 points or an absolute NIHSS score of 0–1 at 24 hours post-intervention. Favorable functional outcome was defined as a modified Rankin Scale (mRS) score of 0–2, or return to pre-stroke mRS at 90 days post-stroke. Mortality was defined as all cause mortality at 90 days. Adverse event measures were intracranial hemorrhage (ICH), defined as any type of ICH at 24 hours post-intervention control CT, and symptomatic ICH (sICH), defined as ICH and decline of >4 points in NIHSS at 24 hours post-intervention. Adverse events directly related to the procedure were categorized as perforation, dissection, or other adverse event (material, cardiovascular, or peripheral/groin).

Statistical analysis

Statistical analyses were performed using SPSS V.29.0. We assessed baseline data distribution for continuous variables by histogram and tested for normality using the Kolmogorov–Smirnov test. Results are presented as mean (SD) for normally distributed continuous data, median (IQR) for continuous data with skewed distribution, and number (percentage) for categorical data. Differences between groups in baseline distributions were assessed using standardized mean difference (SMD).

Differences in procedural time were calculated using independent samples t test and ANCOVA, with the stent retriever group as the reference. ORs of clinical outcome measures were calculated using binary logistic regression with the stent retriever group as the reference. We selected variables for adjustment in the multivariate analysis based on unequal distribution of the variable between groups, defined as SMD >0.1, resulting in adjustment for dense vessel sign, NIHSS pre-intervention, general anesthesia, location of occlusion, tandem occlusion, and whether patients were transported from a primary center. When calculating OR for ENI, we omitted pre-stroke NIHSS from the adjusted variables.

To further explore the robustness of our findings, we conducted a sensitivity analysis focusing on high volume centers that performed >500 interventions per relevant thrombectomy method. This resulted in a single center using aspiration based thrombectomy compared with two centers using stent retriever. We also performed a sensitivity analysis stratifying patients into anterior and posterior circulation stroke. Finally, we carried out a propensity score matched analysis where treatment groups were matched on variables with SMD >0.1 at baseline. Matching was conducted with a caliper of 0.1, which resulted in a post-matching SMD of <0.2 for all relevant variables. A two sided P value ≤0.05 was considered significant. Patients with missing data were omitted from the analysis.

RESULTS

Cohort selection is illustrated in the flowchart (figure 1). This study included 3309 patients treated with EVT during a 4 year

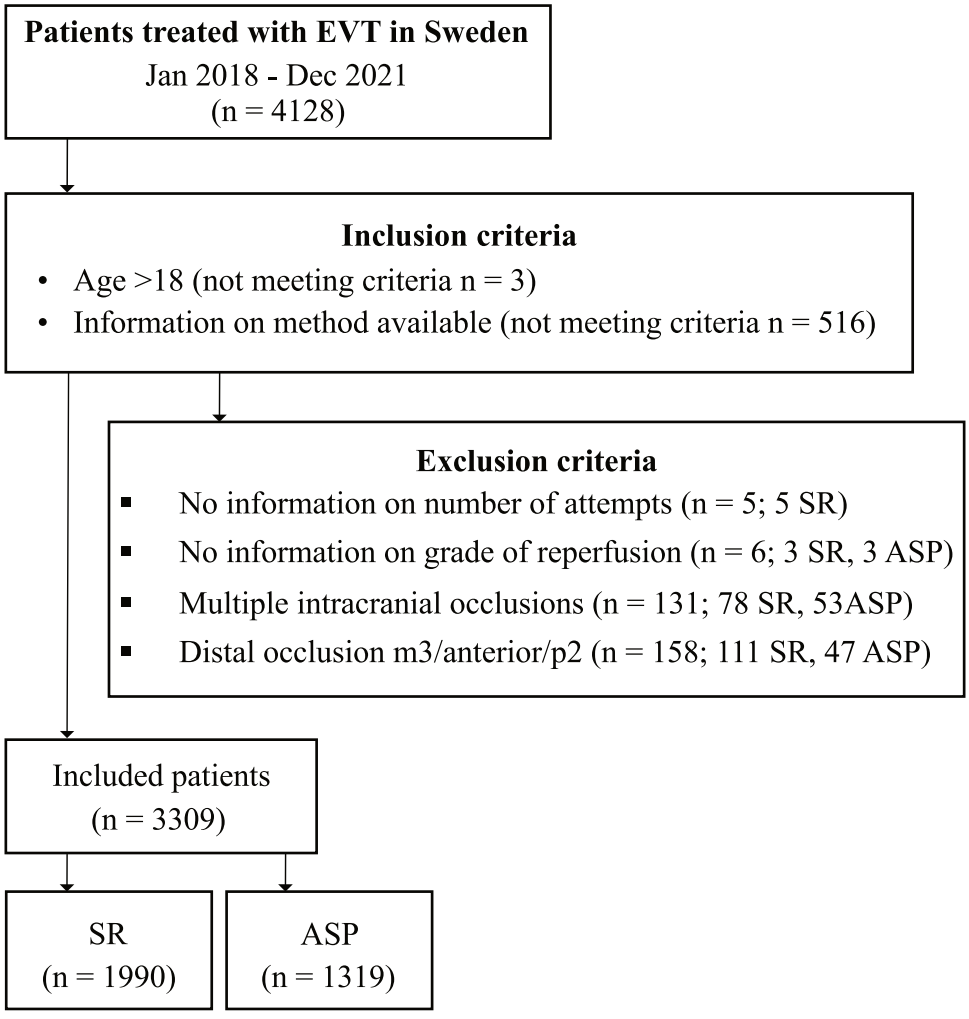

Figure 1 Flowchart of patient selection. ASP, aspiration based thrombectomy; EVT, endovascular therapy; SR, stent retriever.

period (January 2018 to December 2021). Baseline data of the included patients according to the method of thrombectomy are shown in table 1.

First pass reperfusion

FPR was achieved in 745 (37.4%) patients in the stent retriever group and in 479 (36.3%) patients in the aspiration based thrombectomy group, with a between group difference of −1.1% (95% CI −4.5 to 2.2%). Clinical characteristics for FPR, MPR, and non-excellent reperfusion are presented in table 2. There was no difference in the crude OR (cOR) of the FPR rate when comparing aspiration based thrombectomy with stent retriever (cOR 0.95, 95% CI 0.83 to 1.20), or after adjustment for dense vessel sign, general anesthesia, location of occlusion, NIHSS pre-intervention, tandem occlusion, and if patients were transported from the primary center (adjusted OR (aOR) 1.05, 95% CI 0.89 to 1.23).

Procedure time

Procedure time (n=3282 patients) was significantly shorter in with aspiration based thrombectomy when comparing FPR aspiration based thrombectomy with FPR stent retriever (crude mean difference 6.4 min (95% CI 3.4 to 9.3), adjusted mean difference 8.7 min (95% CI 1.8 to 15.6)), and when comparing MPR aspiration based thrombectomy with MPR stent retriever (crude mean difference 9.7 min (95% CI 4.0 to 15.4), adjusted mean difference 17.4 min (95% CI 9.6 to 25.2)). Unadjusted procedure time is presented according to category in table 2.

Clinical outcomes

Data on early neurological outcome were available for 2803 (84.7%) patients and of these, 1811 (64.6%) demonstrated ENI. The corresponding proportions were 1069/1699 (62.9%) in the stent retriever group and 742/1104 (67.2%) in the aspiration based thrombectomy group, with a between group difference of 4.3% (95% CI 0.7 to 7.9%). Data on functional outcome were available for 2431 (73.5%) patients and of these, 902 (37.1%) demonstrated favorable functional outcome. The proportions of favorable outcome were 548/1478 (37.1%) in the stent retriever group and 354/953 (37.1%) in the aspiration based thrombectomy group, with a between group difference of −0.1% (95% CI −0.4 to 0.4%). Data on mortality were available for 3132 (94.7%) patients and of these, 663 (21.2%) had died at 3 months. In the stent retriever group, the corresponding proportion was 406/1907 (20.4%) and in the aspiration based thrombectomy group 257/1226 (19.5%), with a between group difference of −0.9% (95% CI −1.9 to 3.7%).

Table 1 Patient baseline, current event, and procedure data for the two methods of endovascular treatment

Characteristics	Stent retriever (n=1990)	Aspiration-based thrombectomy (n=1319)	SMD
Clinical data			
Age (years) (median (IQR), N)	75 (66–82), 1936	75 (66–82), 1267	0.015
Men (n/N (%))	984/1907 (52)	659/1226 (54)	0.043
Transferred from primary stroke center (n/N (%))	1229/1990 (62)	710/1318 (54)	0.164
SBP at baseline (mm Hg) (median (IQR), N)	149 (130–165), 1419	150 (132–170), 1208	0.051
Pre-stroke mRS 0–1 (n/N (%))	1399/1964 (71)	909/1288 (71)	0.023
Off-hour treatment (n/N (%))	1217/1990 (61)	812/1319 (62)	0.008
Medical history (n/N (%))			
Atrial fibrillation	872/1873 (47)	535/1218 (44)	0.058
Diabetes	375/1902 (20)	250/1219 (21)	0.018
Dyslipidemia	627/1894 (33)	391/1214 (32)	0.016
Hypertension	1215/1897 (64)	745/1221 (61)	0.064
Previous stroke	278/1900 (15)	156/1222 (13)	0.057
Smoking	230/1534 (15)	147/1027 (14)	0.021
Oral anticoagulation	372/1893 (20)	204/1215 (17)	0.077
Antiplatelet therapy	443/1895 (23)	289/1216 (24)	0.012
Current stroke event			
Admission NIHSS (median (IQR), N)	15 (10–19), 1906	16 (10–20), 1231	0.120
Occlusion location (n/N (%))			0.361
Intracranial ICA	299/1990 (15)	228/1319 (17)	
Extracranial ICA	22/1990 (1)	96/1319 (7)	
M1	973/1990 (49)	577/1319 (44)	
M2	535/1990 (27)	208/1319 (16)	
Basilary artery/P1	149/1990 (8)	202/1319 (15)	
Tandem occlusion (n/N (%))	123/1990 (6)	208/1319 (16)	0.323
IV-rtPA (n/N (%))	839/1983 (42)	498/1309 (38)	0.012
MCA infarct size>1/3 at baseline (n/N (%))	85/1984 (4)	68/1314 (5)	0.042
Dense vessel sign (n/N (%))	1272/1990 (64)	616/1319 (47)	0.354
Collaterals (n/N (%))			0.078
Good	443/1904 (23)	245/1239 (20)	
Moderate	660/1904 (35)	345/1239 (28)	
Poor	254/1904 (13)	139/1239 (11)	
Zero	52/1904 (3)	79/1239 (6)	
Not judgeable	495/1904 (26)	431/1239 (35)	
Left side of occlusion (n/N (%))	1008/1903 (53)	631/1188 (53)	0.002
Stroke-to-puncture (min) (median (IQR), N)	240 (159–385), 1528	230 (148–406), 956	0.036
Wake-up stroke (n/N (%))	385/1990 (19)	275/1319 (21)	0.042
General anesthesia (n/N (%))	689/1990 (35)	824/1319 (62)	0.581

All continuous measures are reported as median (IQR), number of patients with available data (N). Binary parameters are reported as n (number of patients)/N (%).
EVT, endovascular treatment ; ICA, internal carotid artery; IV-rtPA, intravenous thrombolysis; M1, first segment of MCA; M2, second segment of MCA; MCA, middle cerebral artery; NIHSS, National Institutes of Health Stroke Scale; P1, first segment of posterior cerebral artery; SBP, systolic blood pressure; SMD, standardized mean difference.

ORs for clinical outcomes for the entire cohort and patients with FPR and MPR are presented in figure 2, with stent retriever as the reference. We found a significant difference in ENI within the whole study cohort in favor of aspiration based thrombectomy (cOR 1.21, 95% CI 1.03 to 1.42; aOR 1.40, 95% CI 1.18 to 1.67) and after adjustment in the MPR group (cOR 1.27, 95% CI 0.94 to 1.70; aOR 1.72, 95% CI 1.22 to 2.42). We found a significant difference in functional outcome in the whole cohort after adjustment (cOR 1.00, 95% CI 0.85 to 1.19; aOR 1.22, 95% CI 1.01 to 1.47). No other significant differences in clinical outcomes were found, but adjusted analysis of mortality almost reached statistical significance favoring aspiration based thrombectomy (cOR 0.94, 95% CI 0.79 to 1.12; aOR 0.82, 95% CI 0.67 to 1.00).

Sensitivity analyses

Data from sensitivity analyses are presented in the online supplemental data. In the sensitivity analysis of high volume centers, the results remained consistent, except for adjusted procedure time in the FPR group and favorable functional outcome in the

Table 2 Clinical characteristics for patients with first pass reperfusion (FRP), multiple pass reperfusion (MPR), and non-excellent reperfusion (NER), and treatment with stent retriever (SR) and aspiration based thrombectomy (ASP), respectively

Current stroke event	FPR-SR (n=745)	FPR-ASP (n=479)	MPR-SR (n=520)	MPR-ASP (n=428)	NER-SR (n=725)	NER-ASP (n=412)
Location (n/N (%))						
M1	349/743 (47)	258/478 (54)	256/518 (49)	141/425 (33)	329/723 (46)	139/410 (34)
M2	199/743 (27)	83/478 (17)	107/518 (21)	45/425 (11)	219/723 (30)	70/410 (17)
ICA intracranial	92/743 (12)	30/478 (6)	79/518 (15)	84/425 (20)	83/723 (12)	54/410 (13)
ICA extracranial	47/743 (6)	33/478 (7)	31/518 (6)	87/425 (21)	44/723 (6)	87/410 (21)
Basilary artery/P1	56/743 (8)	74/478 (16)	45/518 (9)	68/425 (16)	48/723 (7)	60/410 (15)
Transferred from primary center	443/745 (60)	240/478 (50)	311/520 (60)	219/428 (51)	478/725 (66)	251/412 (61)
Dense vessel sign (n/N (%))	482/745 (65)	231/470 (48)	335/520 (64)	204/428 (48)	455/725 (63)	180/412 (44)
IV-rtPA (n/N (%))	330/743 (44)	173/476 (36)	212/518 (41)	174/423 (41)	298/723 (41)	151/410 (37)
Baseline NIHSS (median (IQR), N)	15 (10–19), 715	15 (9–20), 446	16 (9–19), 494	17 (12–21), 405	15 (11–20), 695	17 (11–20), 380
General anesthesia (n/N (%))	247/745 (33)	282/479 (59)	207/520 (40)	286/428 (67)	235/725 (32)	256/412 (62)
Procedure data						
eTICI 3 (n/N (%))	487/745 (65)	325/479 (68)	254/529 (49)	205/428 (48)	NA	NA
eTICI 2c (n/N (%))	258/745 (35)	154/479 (32)	266/529 (51)	223/428 (52)	NA	NA
eTICI 2b (n/N (%))	NA	NA	NA	NA	481/725 (66)	307/412 (75)
eTICI 0–2a (n/N (%))	NA	NA	NA	NA	244/725 (34)	105/412 (25)
Balloon guide catheter (n/N (%))	583/737 (79)	71/476 (15)	387/513 (75)	109/425 (26)	513/716 (72)	76/412 (18)
IA-rtPA (n/N (%))	NA	NA	17/520 (3)	2/428 (1)	29/725 (4)	6/412 (2)
No of attempts (median (IQR), N)	1 (1-1), 745	1 (1-1), 479	2 (2-3), 520	3 (2-4), 428	2 (1-4), 725	3 (2-5), 412
At least one attempt with other method (n/N (%))	NA	NA	35/520 (7)	211/428 (49)	37/725 (5)	170/412 (41)
Adverse events (n/N (%))						
Migration to new territory	10/732 (1)	4/478 (1)	28/513 (6)	17/427 (4)	77/717 (11)	28/412 (7)
Perforation	7/745 (1)	2/479 (0)	4/520 (1)	3/428 (1)	23/725 (3)	17/412 (4)
Dissection	4/745 (1)	1/479 (0)	4/520 (1)	5/428 (1)	10/725 (1)	7/412 (2)
ICH	136/745 (18)	55/479 (12)	151/520 (29)	62/428 (15)	243/725 (34)	92/412 (22)
sICH	6/745 (1)	2/479 (0)	12/520 (2)	6/428 (1)	39/725 (5)	12/412 (3)
MCA infarct >1/3 at 24 hours, new compared with baseline (n/N (%))	74/745 (10)	33/479 (7)	63/520 (12)	58/428 (14)	187/725 (26)	99/412 (24)
Time points						
Stroke-to-door (median (IQR), N)	180 (85–300), 557	200 (87–372), 339	197 (98–337), 371	182 (84–340), 288	216 (132–374), 515	205 (110–370), 295
Stroke-to-CT (median (IQR), N)	116 (68–270), 584	120 (71–325), 348	135 (70–319), 394	117 (73–315), 294	155 (71–346), 541	112 (68–304), 299
CT-to-puncture (median (IQR), N)	68 (42–113), 734	62 (38–118), 469	60 (38–109), 513	62 (40–119), 413	77 (42–124), 716	81 (42–144), 403
Procedure time (mean (SD), N)	36 (24), 740	29 (28), 474	70 (41), 513	60 (49), 422	79 (50), 722	73 (52), 411

All continuous measures are reported as median (IQR), number of patients with available data (N). Binary parameters are reported as n (number of patients)/N (%).
eTICI, extended Treatment in Cerebral Ischemia score; IA-rtPA, intra-arterial thrombolysis; ICA, internal carotid artery; ICH, intracerebral hemorrhage; IV-rtPA, intravenous thrombolysis; M1, first segment of MCA; M2, second segment of MCA; MCA, middle cerebral artery; NIHSS, National Institutes of Health Stroke Scale; P1, first segment of posterior cerebral artery; sICH, symptomatic intracerebral hemorrhage.

combined group (defined as FPR, MPR, and NER), showing no significant association with choice of first line method (online supplemental table S2 and online supplemental figure S1, respectively).

For anterior stroke patients, our findings were consistent with the main analysis, although the association between functional outcome and choice of firstline method in the combined group was not statistically significant (online supplemental figure S2).

For patients with a posterior stroke, findings differed from the main analysis, as adjusted procedure times and ENI did not show a significant association with choice of firstline method. However, we found significant differences favoring aspiration based thrombectomy in functional outcome within the combined group (cOR 1.88, 95% CI 1.1 to 3.24; aOR 2.3, 95% CI 1.16 to 4.48), specifically within the FPR groups (cOR 2.68, 95% CI 1.12 to 6.39; aOR 3.86, 95% CI 3.28 to 11.64) and unadjusted difference in mortality within the combined group (cOR 0.58, 95% CI 0.36 to 0.93; aOR 0.52, 95% CI 0.27 to 1.01) (online supplemental figure S3).

Propensity score matching resulted in 1104 matched pairs with all matched variables reaching <0.2 SMD (online supplemental table S7). Results were consistent with the main analysis except for a significantly increased chance of a favorable functional outcome in the combined group (OR 1.28, 95% CI 1.05 to 1.57) and FPR groups (OR 1.4, 95% CI 1.01 to 1.94), and lower mortality in the whole cohort (OR 0.79, 95% CI 0.65 to 0.98),

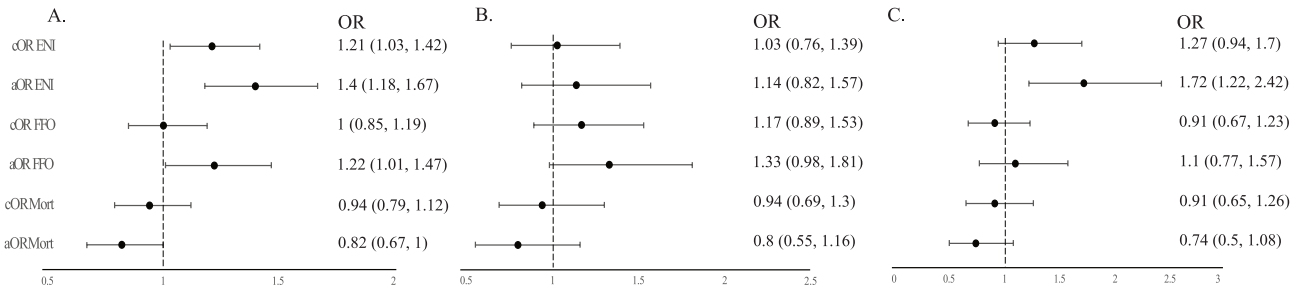

Figure 2 Clinical outcomes according to group, displayed as crude/adjusted OR (cOR/aOR, 95% CI), with stent retriever as the reference. (A) Whole studied cohort. (B) First pass reperfusion. (C) Multiple pass reperfusion. Data were adjusted for dense vessel sign, general anesthesia, location of occlusion, National Institutes of Health Stroke Scale score pre-intervention, tandem occlusion, and if patients were transported from a primary center. ENI, early neurological improvement; FFO, favorable functional outcome; Mort, mortality at 3 months.

all favoring aspiration based thrombectomy (online supplemental figure S4). Data on method of thrombectomy according to center are presented in online supplemental table S10.

DISCUSSION

In this register based study with consecutive patients treated with thrombectomy for LVO stroke at six centers in Sweden, we found no difference in the FPR rate between aspiration based thrombectomy and stent retriever as the firstline method. However, we found a shorter procedure time favoring aspiration based thrombectomy, both in patients with FPR and MPR. This difference seemed to translate into improved clinical outcome in terms of ENI and favorable functional outcome, both in favor of aspiration based thrombectomy as the first-line method.

Regarding FPR rate and shorter procedure time in aspiration based thrombectomy, our results are in line with previous studies. The COMPASS trial reported by Turk *et al* found no difference in FPR rate in eTICI 2b or above patients when comparing aspiration based thrombectomy with a stent retriever, but a shorter procedure time favoring aspiration based thrombectomy.[5] Ducroux *et al*, using data from the ASTER trial, found no difference in FPR rate. In the original ASTER trial by Lapergue *et al*, procedure time in aspiration based thrombectomy was 7 min shorter than stent retriever treatment, although the difference was not statistically significant (P=0.1).[4 10] Gupta *et al* found a significant difference in FPR rate, but being an industry sponsored registry study only devices of a particular brand were compared. No difference in total procedure time was found although aspiration based thrombectomy was faster in the FPR group.[6]

In contrast with our results, previous studies have not found any association between the firstline method and clinical outcome in anterior circulation stroke.[5 10] However, most previous studies have been of limited size and/or designed as clinical trials, not necessarily reflecting the true clinical patient panorama. Similar to our results, Bernsen *et al* found a shorter procedure time and a significant difference in functional outcome in posterior circulation stroke.[9] Bekri *et al* found a shorter procedure time and lower mortality favoring aspiration in posterior circulation stroke.[11] Thus, taken together, these results indicate a shorter procedure time and improved clinical outcome in aspiration based thrombectomy in both posterior and anterior circulation stroke patients.

Importantly, there is a strong similarity in the aspiration based thrombectomy and stent retriever cohorts with respect to age and risk factors (eg, smoking and comorbidities). It has been proposed that previous studies indicating a similarity in clinical outcomes had selection bias due to patients selected for aspiration based thrombectomy being younger, healthier, and with relatively easy access, while more technically challenging patients were treated with a stent retriever.

However, patients treated with aspiration based thrombectomy received general anesthesia to a much higher degree. One potential reason is that Sahlgrenska University Hospital, where the majority of aspiration based thrombectomy cases were performed, is organized with a dedicated anesthesia team for interventional neuroradiology, where rapid anesthesia induction has been a key focus area, making this the preferred option. Stroke-to-puncture time between treatment groups is similar and we have adjusted for general anesthesia in the multivariate models.

It has been suggested that procedure time rather than the number of attempts drives clinical outcome and that no preset number of attempts can predict futile recanalization.[12] In our study, the MPR aspiration group compared with the MPR stent retriever group was associated with improved ENI and shorter procedure time despite indications of a higher number of attempts. Previous studies have suggested that every minute of reduced time to treatment gives on average of 4.2 days of increased healthy life.[13]

Many centers using a stent retriever have adapted a combined technique using a stent retriever in combination with a proximal aspiration catheter. In aspiration based thrombectomy, a more stepwise approach is often used where a stent retriever could be added through the distal aspiration catheter if needed, without having to exchange the entire system. Due to the stepwise approach and lower inherent material cost, aspiration based thrombectomy significantly reduces costs compared with stent retriever .[5 14–16]

The major strength of this study was the large nationwide patient registry of consecutive patients, reflecting a true clinical cohort and representing the largest comparative study of stent retriever and aspiration based thrombectomy. However, the study was retrospective and had potential limitations inherent in this study design. The grade of recanalization was reported by the operator, and previous studies have shown that operators tend to overestimate achieved reperfusion compared with the core laboratory.[17]Moreover, despite attempt to standardize registry reporting, a potential risk of individual misclassification existed which could have influenced data quality. In addition,

no histological data were available and previous studies suggest that the methods respond differently to certain histological compositions.[18]

CONCLUSION

Our data suggest that aspiration based thrombectomy was superior to stent retriever thrombectomy in terms of procedure times and clinical outcomes. However, the FPR rate did not differ between the two methods.

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