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ABSTRACT

BACKGROUND AND PURPOSE: Angioplasty and stent placement have been described as a bailout technique in individuals with failed thrombectomy. We aimed to investigate Stent retriever AssIsted Lysis (SAIL) with tirofiban before angioplasty and stent placement.

MATERIALS AND METHODS: Patients from 2 comprehensive stroke centers were reviewed (2020–2023). We included patients with failed thrombectomy and/or underlying intracranial stenosis who received SAIL with tirofiban before the intended angioplasty and stent placement. SAIL consisted of deploying a stent retriever through the occluding lesion to create a bypass channel and infuse 10 mL of tirofiban for 10 minutes either intra-arterially or IV. The stent retriever was re-sheathed before retrieval. The primary end points were successful reperfusion (expanded TICI 2b–3) and symptomatic intracerebral hemorrhage. Additional end points included 90-day mRS 0–2 and mortality.

RESULTS: After a median of 3 (interquartile range, 2–4) passes, 44 patients received the SAIL bridging protocol with tirofiban, and later they were considered potential candidates for angioplasty and stent placement bailout (43.2%, intra-arterial SAIL). Post-SAIL successful reperfusion was obtained in 79.5%. A notable residual stenosis (>50%) after successful SAIL was observed in 45.7%. No significant differences were detected according to post-SAIL: successful reperfusion (intra-arterial SAIL, 80.0% versus IV-SAIL, 78.9%; $P = .932$), significant stenosis (33.3% versus 55.0%; $P = .203$), early symptomatic re-occlusion (0% versus 8.0%; $P = .207$), or symptomatic intracerebral hemorrhage (5.3% versus 8.0%; $P = .721$). Rescue angioplasty and stent placement were finally performed in 15 (34.1%) patients (intra-arterial SAIL 21.0% versus IV-SAIL 44%; $P = .112$). At 90 days, mRS 0–2 (intra-arterial SAIL 50.0% versus IV-SAIL 43.5%; $P = .086$) and mortality (26.3% versus 12.0%; $P = .223$) were also similar.

CONCLUSIONS: In patients with stroke in which angioplasty and stent placement are considered, SAIL with tirofiban, either intra-arterial or IV, seems to safely induce sustained recanalization, offering a potential alternative to definitive angioplasty and stent placement.

ABBREVIATIONS: A&S = angioplasty and stenting; eTICI = expanded TICI; EVT = endovascular treatment; IA = intra-arterial; ICAD = intracranial atherosclerotic disease; ICAS-LVO = intracranial atherosclerosis–related large-vessel occlusion; IQR = interquartile range; LVO = large-vessel occlusion; MT = mechanical thrombectomy; SAIL = Stent retriever–AssIsted Lysis; sICH = symptomatic intracerebral hemorrhage; SR = stent retriever

Mechanical thrombectomy (MT) with conventional devices such as stent retrievers (SRs) and aspiration catheters has become the standard of care for patients presenting with ischemic stroke due to a large-vessel occlusion (LVO).[1] However, MT fails to achieve successful reperfusion in approximately 10%–20% of patients. The optimal MT strategy to address occlusions refractory to conventional thrombectomy devices remains unclear. In these cases, an underlying intracranial atherosclerotic disease (ICAD) is usually suspected,[2,3] and repeat thrombectomy attempts may only lead to increased activation of the underlying unstable plaque, decreasing the chances of sustained recanalization at the end of the procedure due to in situ thrombosis and re-occlusion despite final rescue with angioplasty and stent placement.[4,5]

A recent study reported that alternative techniques, beyond SR and aspiration thrombectomy, may be required in up to 70% of patients with an ICAD-related LVO, in contrast to the 7% observed among in individuals with embolic occlusions.[5] Several

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SUMMARY

PREVIOUS LITERATURE: The optimal mechanical thrombectomy strategy to address occlusions refractory to conventional thrombectomy devices remains unclear. Repeated thrombectomy attempts may lead to increased activation of the underlying unstable plaque, in situ thrombosis, and re-occlusion. Several rescue treatments after failed MT have been proposed to achieve successful reperfusion; including balloon angioplasty, intracranial stent placement, or glycoprotein IIb/IIIa inhibitors infusion.

KEY FINDINGS: The Stent retriever AssIsted Lysis (SAIL) is a novel technique in which stent retriever deployment temporarily dilates the lesion creating a bypass channel that ensures arrival of tirofiban to the whole target plaque. The SAIL technique with tirofiban, either intra-arterial or intravenous, seems to safely induce sustained recanalization, potentially avoiding definitive intracranial rescue stent placement.

KNOWLEDGE ADVANCEMENT: The present work provides new clinical insights of the SAIL technique as a potential alternative to traditional bailout when conventional thrombectomy devices fail to recanalize the occluded artery. Further studies are warranted to confirm the efficacy and determine the optimal administration route of tirofiban.

rescue treatments after failed MT have been proposed to achieve successful reperfusion, including balloon angioplasty, intracranial stent placement, or glycoprotein IIb/IIIa inhibitor infusion.[6-9]

Stent retriever AssIsted Lysis (SAIL) with tirofiban is a novel technique in which SR deployment temporarily dilates the lesion creating a bypass channel that ensures arrival of the concomitantly infused drug to the whole target plaque. We aimed to describe the potential benefits of SAIL with tirofiban as a bridging technique before angioplasty and stent placement (A&S) to induce reperfusion in patients with suspected intracranial atherosclerosis–related large-vessel occlusion (ICAS-LVO) and/or refractory occlusions.

MATERIALS AND METHODS

This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statements. All procedures were conducted in strict adherence to applicable guidelines and regulations.[10,11] The study protocol was reviewed and approved by the Vall d'Hebron Hospital Ethics Committee, approval No. PR(AG)434/2023. Because of the retrospective nature of this study, the need for written informed consent was waived.

Data Availability

Anonymized data supporting the findings of the current study are available for any qualified investigator on reasonable request to the corresponding author.

Study Design and Population

We performed a retrospective cross-sectional study based on a prospectively maintained database of patients with an acute ischemic stroke undergoing endovascular reperfusion treatment at 2 European comprehensive stroke centers. We included patients with an intracranial LVO (intracranial ICA, MCA segments M1 and M2, and vertebral and basilar arteries) who underwent endovascular treatment (EVT) from January 2020 to September 2023 and were expected to receive A&S after at least 1 unsuccessful pass of MT (TICI 0–2a) with an SR or direct aspiration and/or presented with an underlying primary or residual angiographic stenosis. All patients received SAIL as a bridging therapy before traditional bailout. Exclusion criteria were admission after 24 hours from stroke-symptom onset and the presence of an isolated extracranial occlusion of the ICA.

EVT

All procedures were performed according to institutional protocols based on European Stroke Organization guidelines.[12] First-line EVT was performed with a commercially available SR and/or aspiration catheters. The reasons to switch to SAIL were the following: 1) incomplete reperfusion (expanded TICI [eTICI] 0-2a) and/or a trend toward re-occlusion, 2) underlying primary or residual stenosis, and 3) persistence of occlusive/subocclusive thrombus. Decisions to perform SAIL, the route of tirofiban administration (intra-arterial versus IV), and adoption of further bailout/rescue techniques (intracranial angioplasty ± intracranial stent placement [A&S]) were made according to neurointerventionalists' criteria. The residual stenosis degree was assessed according to the Warfarin-Aspirin Symptomatic Intracranial Disease Study criteria.[13]

SAIL Technique

SAIL was adopted as bridging before proceeding with definitive A&S, according to neurointerventionalists' criteria after a variable number of failed MT attempts. A microcatheter with a microguidewire was navigated through a distal-access catheter distal to the lesion. An SR was deployed over the occlusion to dilate the lesion and create a temporary bypass channel. Tirofiban infusion was then initiated by either the intra-arterial (IA) route through the distal-access catheter positioned at the proximal end of the SR (IA-SAIL group) or intravenously (IV-SAIL group). The bolus infusion was maintained for 10 minutes, and the standard dose was 10 μg/kg. Once the tirofiban infusion was completed, the SR was gently re-sheathed into the microcatheter before retrieval to avoid friction and reactivation of the underlying plaque. Recanalization was assessed before and after the rescue procedures (angioplasty and/stent placement) were adopted (if performed) during the hyperacute EVT procedure. In most cases, the initial tirofiban administration was followed by a continuous IV infusion (0.15 μg/(kg $\times$ min) during the next 12–24 hours. In Fig 1, an illustrative case of the procedure is presented.

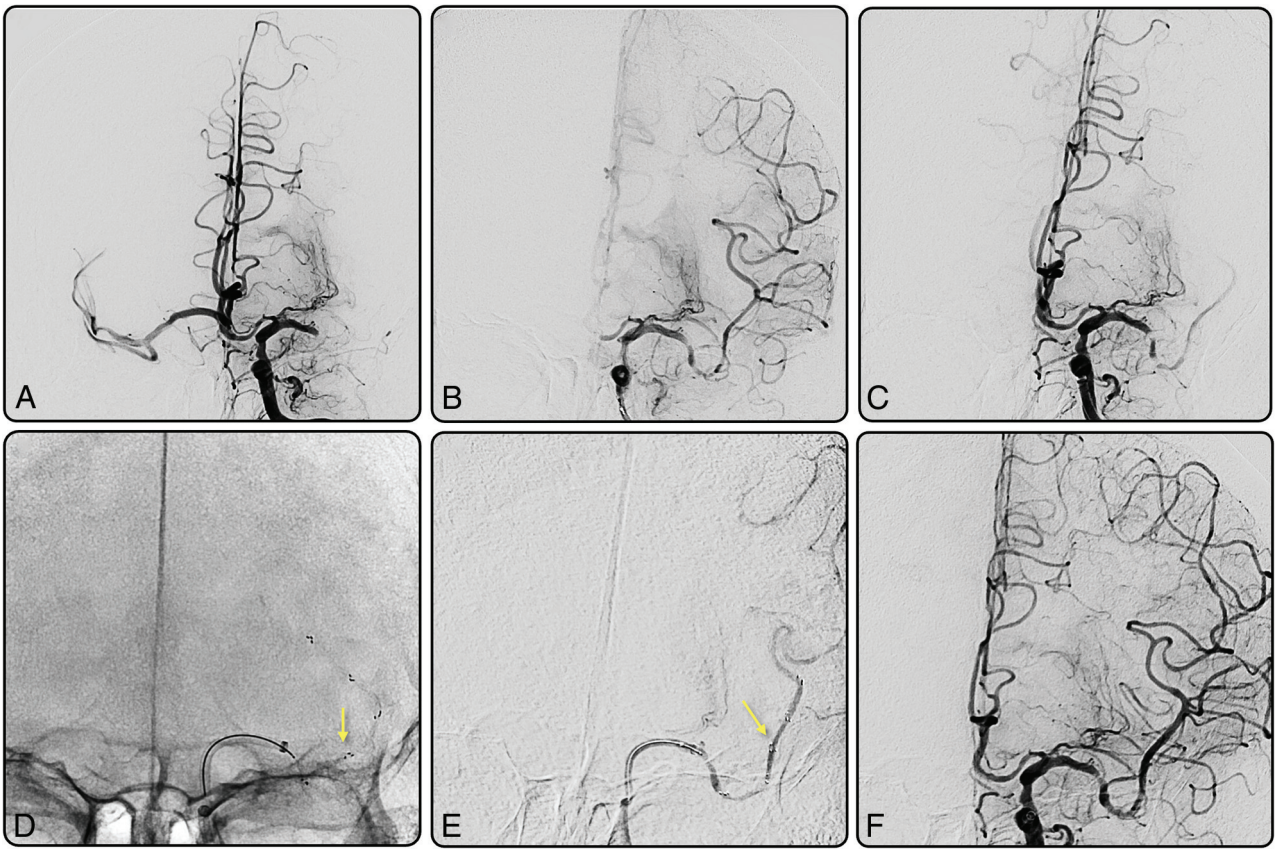

FIG 1. Illustrative case of SAIL with IA tirofiban. *A*, First angiography run shows MCA occlusion (segment M1). After 2 (*B*) and 3 (*C*) attempts of MT with an SR and distal aspiration, there is partial recanalization with a trend to re-occlusion. An SR was deployed over the lesion to create a bypass channel (*D*), and tirofiban was locally infused (*E*) for 10 minutes through a distal-access catheter. An angiogram was obtained to determine the recanalization grade showing successful reperfusion. No re-occlusion was reported at follow-up (*F*). *D*, The *yellow arrow* shows the stent retriever deployed through the occlusive lesion. *E*, The *yellow arrow* shows the created bypass channel and the administration of tirofiban mixed with contrast to ensure the flow.

Clinical and Radiologic Parameters

Recorded demographic and clinical variables included age, sex, baseline mRS, medical comorbidities, stroke severity assessed by NIHSS, admission ASPECTS, workflow times (symptom onset, imaging, and groin puncture), and administered reperfusion therapies.

The degree of reperfusion was determined prospectively by consensus between the interventionalist and the vascular neurologist immediately after the procedure using the eTICI score. Patients were considered to have achieved successful reperfusion if at least 50% of downstream reperfusion was attained (eTICI ≥ 2b50).

Symptomatic intracerebral hemorrhage (sICH), 90-day mRS, and mortality were recorded as clinical and safety outcomes. sICH was defined as any intracranial hemorrhage according to Heidelberg Bleeding Classification that led to neurologic deterioration, as reflected by the NIHSS score worsening of ≥4.[14] Early symptomatic re-occlusion was defined as a neurologic deterioration (NIHSS score worsening of ≥4) associated with re-occlusion of the initially recanalized target artery in the first 24 hours. The degree of recanalization and re-occlusion at 24 hours was assessed by CT/MRA and/or transcranial Doppler according to local center guidelines. At 90 days, functional independence was defined as mRS 0–2.

Statistical Analysis

Kolmogorov-Smirnov and Shapiro-Wilk tests were used to assure the normality of continuous variables. Categoric variables were presented as absolute values and percentages, and continuous variables, as median, interquartile range (IQR) or mean (SD) as indicated. Statistical significance for intergroup differences was assessed by the Pearson χ^2 test or the Fisher exact test for categoric variables and the Mann-Whitney *U* test or Student *t* test as appropriate to continuous variables. Multivariable binary logistic regression analyses were modeled to determine the association between the tirofiban route of administration and outcomes. Multivariable analyses were adjusted using variables that presented a statistically significant association or clinical relevance with the explored outcome. Five patients with premorbid mRS 3 were excluded from functional independence analysis.

A P value $< .05$ was considered statistically significant. All analyses were performed using the SPSS Statistics software, Version 25 (IBM).

RESULTS

From a total of 1630 patients who underwent EVT for an intracranial LVO, 44 (2.7%) patients received the SAIL bridging protocol with tirofiban, and later they were considered potential

Table 1: Baseline characteristics and demographics

	All Patients ($n = 44$)	IV Tirofiban ($n = 25$)	IA Tirofiban ($n = 19$)	*P* Value
Age (mean) (yr)	70 (SD, 14)	65 (SD, 15)	77 (SD, 9)	.003
Sex (male) (No. %)	21 (47.7%)	11 (44.0%)	10 (52.6%)	.570
Risk factors (No. %)				
Former or current smoker	9 (20.4%)	4 (16.3%)	5 (26.3%)	.250
Hypertension	30 (68.2%)	14 (56.0%)	16 (84.2%)	.047
Diabetes mellitus	14 (31.8%)	4 (16.0%)	10 (52.6%)	.010
Dyslipidemia	17 (38.6%)	7 (28.9%)	10 (52.6%)	.096
Atrial fibrillation	5 (11.4%)	1 (4.0%)	4 (21.1%)	.077
Ischemic heart disease	8 (18.2%)	3 (12.0%)	5 (26.3%)	.223
Active oncological disease	0 (0%)	0 (0%)	0 (0%)	NA
Previous stroke	3 (6.8%)	1 (4.0%)	2 (10.5%)	.395
Premorbid mRS (median, IQR)	0 (0–1)	0 (0–0)	1 (0–2)	<.001
Baseline NIHSS (median, IQR)	12 (8–17)	11 (7–18)	15 (10–17)	.484
Occlusion level (No. %)				.041
Intracranial ICA	6 (13.6%)	3 (12.0%)	3 (15.8%)	
MCA M1	25 (56.8%)	16 (50.0%)	10 (52.6%)	
MCA M2	7 (15.9%)	1 (4.0%)	6 (31.6%)	
Intracranial VA	1 (2.3%)	1 (4.0%)	0 (0%)	
Basilar artery	5 (11.4%)	5 (20.0%)	0 (0%)	
IV thrombolysis (No. %)	14 (31.8%)	9 (36.0%)	5 (26.3%)	.495
Wake-up stroke (No. %)	12 (27.3%)	5 (20.0%)	7 (36.8%)	.214
Onset to imaging (mean) (min)	300 (SD, 266)	253 (SD, 249)	364 (SD, 284)	.175
Onset-to-groin time (mean) (min)	411 (SD, 302)	412 (SD, 318)	410 (SD, 288)	.980
ASPECTS (median, IQR)	9 (8–10)	9 (8–9)	9 (8–10)	.208
Symptomatic IAC (No. %)	16 (36.4%)	12 (48.0%)	4 (21.1%)	.066
Stroke etiology (No. %)				.082
Cardioembolic	10 (22.7%)	2 (8.0%)	8 (42.1%)	
Atherothrombotic (ICAS-LVO)	27 (61.4%)	18 (72.0%)	9 (47.4%)	
Undetermined	3 (6.8%)	2 (8.0%)	1 (5.3%)	
Dissection	2 (4.5%)	2 (8.0%)	0 (0%)	
Other	2 (4.5%)	1 (4.0%)	1 (5.3%)	

Note:—IAC indicates intracranial artery calcification; NA, not applicable; VA, vertebral artery.

candidates for A&S bailout. Twenty-five patients (56.8%) received IV-SAIL, while 19 patients (43.2%) received IA-SAIL. The mean age was 70 (SD, 14) years, 21 patients (47.7%) were men, and the median premorbid mRS was 0 (IQR, 0–1). The median NIHSS score at admission was 12 (IQR, 8–17). The occlusion locations were as follows: ICA (6, 13.6%), MCA M1 (25, 56.8%), M2 (7, 15.9%), vertebral artery (1, 2.3%), and basilar artery (5, 11.4%). ICAD stroke etiology was confirmed in 27 patients (61.4%).

Table 1 summarizes the baseline characteristics and demographics according to the route of administration of tirofiban.

Angiographic Outcomes

The rate of successful reperfusion (eTICI ≥2b) with conventional MT was 18.2% (8/44). The 8 patients with eTICI ≥2b received SAIL (4 in the IV-SAIL group and 4 in the IA-SAIL group [21.1%, $P = .667$]) because a significant >50% underlying stenosis persisted at the site of occlusion despite successful recanalization. The other main reasons to indicate SAIL with tirofiban were incomplete reperfusion (eTICI 0–2a: 11/44, 25.0%) and immediate re-occlusion (16/44, 36.4%). The median number of failed conventional thrombectomy attempts before adopting SAIL was 3 (IQR, 2–4). The rate of sustained successful reperfusion after the SAIL technique was 79.5% (35/44), regardless of the administration route of tirofiban (IV: 80% versus IA: 78.9%; $P = .932$).

The overall rate of persistent significant stenosis after successful SAIL was 45.7% (16/35) with no differences between IA-SAIL (33.3%, 5/15) and IV-SAIL (55.0%, 11/20; $P = .203$). Rescue A&S was finally performed in 15 patients (overall, 34.1%: IA-SAIL 4/19, 21.1% versus IV-SAIL 11/25, 44.0%; $P = .112$). After rescue A&S, the rate of successful reperfusion increased to 88.6%.

After we adjusted for confounders in a multivariate model (Online Supplemental Data), no differences were observed between IA-SAIL and IV-SAIL regarding successful reperfusion after SAIL (OR, 0.2; 95% CI, 0.0–10.8; $P = .426$) or at the end of the procedure, including A&S bailout (OR, 0.04; 95% CI, 0.0–2.75; $P = .137$).

Two periprocedural major complications were recorded (1 intracranial dissection and 1 perforation); both occurred during A&S bailout. A detailed description of endovascular treatment characteristics is presented in Table 2.

Clinical and Safety Outcomes

Clinical and safety outcomes are shown in Table 3 and the Online Supplemental Data.

At 24 hours, the median NIHSS score was 11 (IQR, 5–18), with no significant differences between IA-SAIL (14 [7–21]) and IV-SAIL (9 [5–15]; $P = .079$). Additionally, 2 patients (8%) in the IV-SAIL group experienced an early symptomatic re-occlusion but none (0%) in the IA-SAIL group ($P = .207$) did.

The sICH rate was 6.8% (IA-SAIL 5.3% versus IV-SAIL 8.0%, $P = .721$). Eleven patients (25.0%) experienced a mild asymptomatic SAH. At 3 months, the mortality rate was 18.2% (IA-SAIL 26.3% versus IV-SAIL 12.0, $P = .223$).

Table 2: Characteristics of endovascular treatment

	All Patients ($n = 44$)	IV Tirofiban ($n = 25$)	IA Tirofiban ($n = 19$)	*P* Value
First-line endovascular technique (No. %)				<.001
ADAPT	17 (38.6%)	15 (60.0%)	2 (10.5%)	
SR alone	4 (9.1%)	4 (16.0%)	0 (0%)	
SR plus distal aspiration	18 (40.9%)	6 (24.0%)	12 (63.2%)	
SAIL technique with tirofiban	5 (11.4%)	0 (0%)	5 (26.3%)	
Angioplasty/stent placement	0 (0%)	0 (0%)	0 (0%)	
No. of passes before SAIL (median, IQR)	3 (2–4)	4 (2–5)	3 (1–3)	.026
Reason for SAIL with tirofiban (No. %)				<.001
Incomplete reperfusion (eTICI 0–2a)	11 (25.0%)	0 (0%)	11 (57.9%)	
Trend to re-occlusion	16 (36.4%)	14 (87.5%)	2 (12.5%)	
Underlying primary or residual stenosis	13 (29.5%)	8 (32.0%)	5 (26.3%)	
Subocclusive thrombus	4 (9.1%)	3 (12.0%)	1 (5.3%)	
eTICI ≥2b after conventional MT (No. %)	8 (18.2%)	4 (16.0%)	4 (21.1%)	.667
eTICI ≥2b after SAIL with tirofiban (No. %)	35 (79.5%)	20 (80.0%)	15 (78.9%)	.932
Significant residual stenosis (>50%) after successful SAIL (No. %)	16/35 (45.7%)	11/20 (55.0%)	5/15 (33.3%)	.203
Intracranial angioplasty and/or stent placement after tirofiban (No. %)	15 (34.1%)	11 (44%)	4 (21.0%)	.112
Angioplasty	9 (20.5%)	7 (28.0%)	2 (10.5%)	
Stent placement	6 (13.6%)	4 (16.0%)	2 (10.5%)	
Final eTICI ≥2b (No. %)	39 (88.6%)	24 (96.0%)	15 (78.9%)	.077
Groin-to-reperfusion time (mean) (min)	100 (SD, 32)	111 (SD, 34)	87 (SD, 24)	.009
Procedural complications (No. %)				.587
Vasospasm target vessel	3 (6.8%)	2 (8.0%)	1 (5.3%)	
Dissection target vessel	1 (2.3%)	1 (4.0%)	0 (0%)	
Perforation	1 (2.3%)	0 (0%)	1 (5.3%)	
Dissection/perforation at tirofiban bailout	0 (0%)	0 (0%)	0 (0%)	
Distal embolism	5 (11.4%)	2 (8.0%)	3 (15.8%)	
New territory embolism	0 (0%)	0 (0%)	0 (0%)	
In-stent thrombosis	0 (0%)	0 (0%)	0 (0%)	
ICA dissection/vasospasm	0 (0%)	0 (0%)	0 (0%)	

Note:—ADAPT indicates A Direct Aspiration First Pass Technique.

Table 3: Safety and clinical outcomes

	All Patients ($n = 44$)	IV Tirofiban ($n = 25$)	IA Tirofiban ($n = 19$)	*P* Value
Early symptomatic vessel re-occlusion (24 hr) (No. %)	2 (4.5%)	2 (8.0%)	0 (0%)	.207
Degree of recanalization at follow-up (No. %)				.010
Complete recanalization/stenosis <50%	22 (68.8%)	13 (56.5%)	9 (100%)	
Stenosis >50%	6 (18.8%)	6 (26.1%)	0 (%)	
Occlusion	4 (12.5%)	4 (17.4%)	0 (0%)	
NIHSS at 24 hr (median, IQR)	11 (5–18)	9 (5–15)	14 (7–21)	.079
NIHSS at discharge (median, IQR)	8 (2–15)	8 (2–14)	9 (4–21)	.256
sICH (No. %)	3 (6.8%)	2 (8.0%)	1 (5.3%)	.721
Postprocedural SAH (No. %)	11 (25.0%)	5 (20.0%)	6 (31.6%)	.380
90-Day mortality (No. %)	9 (18.2%)	3 (12.0%)	5 (26.3%)	.223
90-Day mRS 0–2 (No. %)	18/39 (46.2%)	10/23 (43.5%)	8/16 (50.0%)	.688
90-Day mRS 0–3 (No. %)	26 (59.1%)	16 (64.0%)	10 (52.6%)	.447

Functional independence (mRS 0–2) was achieved in 46.2% of all patients (8/16, IA-SAIL 50.0% versus IV-SAIL, 43.5%, $P = .688$).

A logistic regression model adjusting for potential confounders did not find a significant association between IA-SAIL or IV SAIL with symptomatic intracranial hemorrhage, mortality, or 90- day disability (Online Supplemental Data).

DISCUSSION

Our study shows that SAIL with tirofiban, both IA and IV, is a safe and effective technique for patients with refractory occlusions and/or suspected underlying intracranial stenosis who are candidates for rescue treatment. The use of this technique could potentially avoid the conversion to intracranial angioplasty and stent placement in many cases or confirm the indication in others. As a result, the present work provides new clinical insight about SAIL as a potential alternative to traditional bailout when conventional thrombectomy devices fail to recanalize the occluded artery. Moreover, the adoption of the SAIL technique in patients with failed recanalization could not only improve reperfusion in these patients but also confirm the underlying etiology to optimize secondary prevention treatment.

In this study focused on patients in whom conventional MT did not succeed, the use of bridging SAIL with tirofiban achieved a sustained successful reperfusion in approximately 80% of patients. Additional rescue treatments were required in only

34.1% of these patients. Our sample size is not large enough to describe the superiority of one administration route over the other; the available data suggest that in selected cases, both IV and IA SAIL with tirofiban seem to be similarly safe and effective. The overall rate of sICH (6.6%) and 90-day mortality (18.2%) were comparable with the rates described in large series of unselected patients receiving EVT with conventional devices approved for MT.[15,16]

The administration of tirofiban in ischemic stroke has been described in multiple studies as a safe and potential choice for acute stroke management, both in the presence of LVO and in cases of minor stroke with unplanned EVT.[15,17-20] Recently, the International Stroke Perfusion Imaging Registry (INSPIRE) study reported that IA tirofiban could be associated with an increased risk of bleeding and death.[21] The authors suggested that an IA bolus injection provides a direct contact of tirofiban with the thrombus, with a dramatic increase in the local drug concentration. They hypothesized that this might cause damage to the BBB leading to cerebral hemorrhage. Another study showed that IA tirofiban could decrease the rates of excellent outcome (90-day mRS 0–1) and functional independence (90-day mRS 0–2) in patients with ICAS-LVO undergoing EVT.[22]

To date, there have been no randomized controlled trials investigating the preferred administration route of tirofiban, and all studies have been based on observational data. In our study, the SAIL technique creates a bypass channel across the clot favoring, on one hand, a direct contact of tirofiban through the whole length of the clot and, on the other, a continuous stream and washout that prevents drug stagnation at high concentrations and BBB damage, potentially avoiding a higher risk of hemorrhage and clinical deterioration. Given that the underlying etiology in most patients was probably related to ICAD, SAIL allowed the administered tirofiban to act rapidly at the whole length of the lesion, stabilizing the plaque and locally inhibiting platelet aggregation. Moreover, re-sheathing the SR into the microcatheter before retrieval prevents new denudation and reactivation of the just-stabilized plaque, thereby reducing the risk of re-occlusion.

In our series, the only 2 patients who presented with an early symptomatic re-occlusion were in the IV tirofiban group, suggesting a potentially greater effect of IA administration. The trends toward reduced A&S conversion and higher functional independence rates also suggest the potential benefit of the IA over the IV route of tirofiban administration. However, this potential benefit needs to be weighed against the potential downside of a heightened risk of mortality. Further randomized controlled trials should be developed to confirm this observation and verify the safety of IA tirofiban treatment.

Rescue conversion to angioplasty and stent placement following failed MT had been reported as an effective treatment, leading to high odds of successful reperfusion and 90-day functional independence, independent of the presence of underlying ICAD.[23-25] However, the rate of sICH in patients who underwent rescue A&S ranged from 7% to 10.5%, which is slightly higher than the rate reported with the SAIL technique (6.8%). Mortality was also higher in large observational series of patients with rescue intracranial stent placement after failed thrombectomy (18.5%–29.9% versus 18.2% in SAIL technique).[4,23,26] Hence, certain scenarios can advise against A&S, such as patients with a large infarct core or a history of intracranial hemorrhage or cases in which the lesion originates in arterial segments rich in perforator arteries at high risk of occlusion after angioplasty due to the snowplow effect.[8] The early adoption of SAIL could prevent increasing endothelial damage caused by repetitive MT attempts, offering a potential alternative before the final decision of A&S conversion is made.

Additional studies are warranted to confirm our observation and fine-tune the treatment algorithms describing the optimal steps in which SAIL and A&S should be considered and adopted. The potential negative impact of increasing MT attempts before SAIL, as observed in cases of A&S bailout, should also be investigated.[7]

Limitations

This study has some limitations due to its inherent retrospective and observational nature, in addition to the relatively small sample size of patients included and the absence of a control group of patients who underwent A&S without SAIL bridging therapy. The clot location (including anterior and posterior LVO) and etiology heterogeneity could dilute the potential benefit of the SAIL technique in a specific etiology such as ICAD. Other limitations include the lack of an independent imaging core laboratory to adjudicate recanalization outcomes and the decision to adopt SAIL or traditional bailout with angioplasty and/or stent placement being at the discretion of the treating neurointerventionalist. For these reasons, the study should be considered as a pilot and used to provide preliminary data for the design of future confirmatory studies.

CONCLUSIONS

In patients with stroke undergoing EVT in which intracranial angioplasty and stent placement are considered as bailout after failed mechanical thrombectomy, the SAIL technique with tirofiban, either IA or IV, seems to safely induce sustained recanalization in a substantial number of patients, potentially avoiding definitive stent placement. Further studies are warranted to confirm the efficacy and determine the optimal administration route of tirofiban.

Disclosure forms provided by the authors are available with the full text and PDF of this article at www.ajnr.org.

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