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Advancing beyond recent randomized controlled trials: Role of Tigertriever13 for distal medium vessel occlusion

Chen Meir Kadosh[1], Ran Brauner[1,2], Johnatan Naftali[1], Keshet Pardo[1,3], Rani Barnea[1], Michael Findler[1,2], Eitan Auriel[1,3] and Guy Raphaeli[1,2]

Abstract

Background and purpose: To assess the safety and efficacy of Tigertriever 13 (T13) (one center experience) for mechanical thrombectomy (MT) in acute ischemic stroke (AIS) in patients with primary or secondary distal, medium-size vessel occlusions (DMVOs).

Methods: We performed a retrospective analysis of all consecutive AIS patients who underwent thrombectomy with T13 for DMVO (from 2018 until the present). Patient's characteristics were analyzed as well as procedural complications, angiographic (modified thrombolysis in cerebral infarction [mTICI]) score, and clinical outcomes (modified Rankin Scale [mRS]).

Results: Our cohort included 43 patients. Male predominance was noticed (60.5%), the median age was 71 years (interquartile range [IQR], 65–83), and 37.2% of patients received IV lytics prior to MT. Our cohort was divided into three sub-groups: (1) primary DMVO (17 patients, 39.5%), (2) secondary DMVO following large vessel occlusion (19 patients, 44.18%), and (3) DMVO related to the non-stroke endovascular procedure, such as aneurysm repair and carotid artery stenting (seven patients, 16.2%). Successful recanalization (mTICI 2b-3) was achieved in most of the patients (37/43, 86.04%). None of the patients have experienced symptomatic intracranial hemorrhage (ICH), and seven patients (16.3%) had asymptomatic ICH. Median mRS score was 3 at day 90 (IQR, 2–5), with 17 patients (39.5%) gained favorable outcome (mRS $\leq$ 2). Mortality was documented among 11.8% in primary DMVO and 10.52% in secondary DMVO.

Conclusions: T13 for MT seems to be safe and effective for DMVO. Clinical outcomes and complications were in line with those described among patients with proximal occlusions. Although considered a remote target, it seems to be technically achievable with a reasonable outcome.

Keywords
Thrombectomy, reperfusion, DMVO, stroke

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Introduction

Mechanical thrombectomy (MT) for acute ischemic stroke (AIS) has become more common over the past decade due to advancements in techniques and devices, improving revascularization rates and outcomes.[1] As a result, MT is now the recommended standard of care for AIS patients with proximal large vessel occlusions (PLVOs).[2,3]

The clinical syndromes of distal medium vessel occlusions (DMVOs) may be devastating. Occlusion of distal arteries reflects loss of cognitive, motor, sensory, and visual function subserved by the cortex and subcortical white matter, and can even lead to death.[1,4,5]

DMVO accounts for 25%–40% of all primary brain vessel occlusions.[5] Due to technical challenges in this vascular territory, they were excluded from main MT studies.[1] Therefore, intravenous thrombolysis (IVT) remains the primary therapy of choice and is more effective for smaller clot burdens of DMVOs compared to PLVOs.[6,7] One meta-analysis did not demonstrate a significant difference between MT to IVT regarding favorable outcomes, occurrence of symptomatic intracranial hemorrhage (sICH), or 90-day mortality.[8] Unfortunately, many contraindications limit its use in clinical practice, and even when in use it fails to recanalize 50%–66% of DMVOs.[5,9]

Recent advancements in smaller, low-profile retrievers have enhanced the capacity to access distal cerebral arteries. A recent study reported a 74% successful recanalization rate in 38 patients with isolated M2 occlusions, using only a solitary device (Mindframe Capture).[10] One such device is an adaptive, mesh-like low-profile stent retriever, designed to pass through a 0.013–0.0165-inch lumen

[1]Department of Neurology, Rabin Medical Center, Petach Tikva, Israel
[2]Interventional Neuroradiology Unit, Rabin Medical Center, Petach Tikva, Israel
[3]Faculty of Medical & Health Sciences, Tel Aviv University, Israel

Corresponding author:
Guy Raphaeli, Department of Neurology, Rabin Medical Center, 39 Jabotinsky, Petach Tikva 4941492, Israel.
Email: graphaeli@gmail.com

microcatheter (Tigertriever 13, Rapid Medical, Yokneam, Israel), and re-raised the role of MT for DMVOs, considering that promising retrospective results were published recently.[11]

Additionally, a recent consensus statement in this evolving endovascular field strongly supports the growing evidence for thrombectomy, with several devices showing strong efficacy and safety.

Our institution is a tertiary stroke and neurointerventional center. We aim to present our preliminary experience (angiographic and clinical outcome) with the smallest currently known low-profile thrombectomy device uniquely dedicated to DMVO.

Methods

This retrospective study was performed in a single center which included all consecutive AIS (age 18–100 years) after receiving approval from the local Institutional Review Board (IRB), informed consent from participants was waived. Patients treated exclusively with Tigertriever13 (T13) device for DMVO between January 2020 and August 2024 (56 months).

Demographic and clinical data were extracted from electronic medical records. All interventions were performed by simultaneous pump-assisted distal aspiration. Angiographic results after the MT procedure were interpreted according to the extended thrombolysis in cerebral infarction (eTICI) classification.[12] The following technical data were collected from the interventional reports: number of passes, time from groin puncture to reperfusion, and technical complications. The primary endpoint was successful recanalization, defined as an eTICI score of 2b-3. Secondary endpoints were safety and short-term as well as 90-day good clinical outcome (modified Rankin Scale [mRS] 0–2). Safety was assessed based on the rate of intracranial hemorrhage (ICH), and symptomatic ICH using the Safe Implementation of Thrombolysis in Stroke-Monitoring Study (SITS-MOST) definition: local or remote PH2 as detected on 24 h (−6 to +6 h) post-procedure CT combined with a neurologic deterioration of ≥4 points NIHSS deterioration at 24 h (± 6 h) of randomization or hemorrhage leading to death within 24 h SITS-MOST criteria.[13] Peri-procedural subarachnoid contrast extravasation or subarachnoid hemorrhage (SAH) depicted on flat-panel cone-beam CT immediately after DMVO thrombectomy was also reported. Short-term clinical outcome was assessed by certified stroke neurologists who reported the NIHSS scores at admission, 24 h after MT, and at discharge. Finally, in-hospital mortality as well as 90-day mortality is also reported.

Patient selection

The following DMVOs were included: A2–A4 segments of the anterior cerebral artery (ACA), M2–M4 segments of the middle cerebral artery (MCA), P2–P4 segment of the posterior cerebral artery (PCA), as well as cerebellar arteries. Patients were classified into three categories: primary isolated DMVO (group 1); secondary DMVO following MT for PLVO—either emboli in new territory (ENT) or emboli in distal territory (EDT)—(group 2); and DMVO related to thromboembolic complications during non-stroke intervention, such as aneurysm or AVM embolization (group 3).

DMVO thrombectomy procedure

All interventions were performed under general anesthesia on biplane angiography systems (AlluraClarity Philips, Netherlands). Vascular access was either trans-femoral ($N = 38$, 88.37%) or trans-radial ($N = 5$, 11.6%). Following positioning of the long sheath (Neuromax 088, Pneumbra, CA, USA) and an aspiration catheter (SOFIA 6F or 5F, Microvention, Tustin, CA, USA) in the internal carotid artery or vertebral artery, 1.3 French 0.0165-inch inner lumen 167 cm Headway Duo (MicroVention, Tustin, CA, USA) was navigated over a 0.014 (Traxcess, MicroVention) or 0.007 wire (Hybrid or Balt) beyond the occlusion site before deploying the T13 device. Distal injections through the microcatheter were performed after crossing the occlusion to exclude contrast extravasation and to ensure its safe position. The T13 was loaded into the microcatheter and advanced towards the occlusion. The proximal marker of the T13 was positioned as close as possible to the proximal part of the thrombus. The device was expanded by a stepwise maneuver (handle-assisted) under permanent fluoroscopy. While expanded, T13 was used to advance more easily the aspiration catheter toward the occlusion site (wedge position).

The attached mechanical slider was used to incrementally expand the device until reaching the desired diameter. The T13 device was then slightly relaxed. In case of excessive tension during pulling, the device was further relaxed to avoid intimal injury. The T13 was pulled into the catheter under continuous negative pressure aspiration.

In this study, no additional devices were utilized, with the sole exception of T13 (first and only intention-to-treat).

Results

During the 4.6-year study period, endovascular treatment was performed in 764 patients with AIS, among them 5.6% (43 patients) had distal occlusions treated only by T13. Furthermore, T13 had been used as a first-line strategy in all patients. Of this cohort, 17/43 (39.5%) patients had primary DMVO (group 1), 19/43 (44.18%) patients had secondary DMVO after PLVO (group 2), and 7/43 (16.27%) patients had DMVO related to non-stroke endovascular procedure (group 3)—three patients during aneurysm treatment, the rest (four patients) during extracranial elective carotid artery stenting. The median age of the entire cohort was 71 years old (range 49–89), and 17 (39.5%) were females. Anticoagulation therapy was

administered pre-procedurally to 18 (41.86%) of all patients. Sixteen (37.2%) patients received IVT. Femoral access was performed in 88% (38 patients) while 12% (five patients) had radial access. Successful recanalization (eTICI 2b-3) was achieved in the majority of the patients (37/43, 86.04%). The median number of passes for the entire cohort was 2.5 (range 1–5). Median mRS day 90 post was 3 (interquartile range [IQR] of 2–5), while 17 patients (39.5%) achieved favorable outcomes (mRS $\leq$ 2), as shown in Figure 1. We accounted for no cases of spasms in our cohort. Overall, 90-day mortality was 16.2% ($n = 7$) but only one patient died from a neurological complication (large infraction).

Two patients (4.6%) had convexial superficial subarachnoid hemorrhage in an immediate CT scan at the end of the procedure (and considered as asymptomatic intracranial hemorrhage, aICH). There was no significant difference between the groups regarding influencing factors, such as time of stroke onset, time to recanalization, and number of passes. Baseline characteristics are summarized in Table 1. Procedural data and early and long-term outcomes are presented in Table 2. Clot location according to DMVO type is reported in Table 3.

Inter-groups differences

Concerning group 1, successful recanalization was achieved in 14/17 (82.35%) patients. The most common clot location was M2 (11 patients, 64.7%). The median NIHSS score at admission was 13 (IQR, 8–15) and 6 (IQR, 1–6) at discharge (i.e. NIHSS improvement of 53.8% from baseline). Two patients died in the hospital, the first was 87 years old and died due to respiratory failure, and the other patient died from sudden asystole during hospitalization, none of the patients had sICH (0%). Seven patients (41.2%) had a favorable outcome at day 90. Median mRS at day 90 was 3 (IQR 1.5–5). Among 19 patients in group 2, successful recanalization was achieved in 17 of 19 (89.47%) patients. Similarly to group 1, the most common occlusion site was M2 (five patients, 26%) followed by M3 occlusion (four patients, 21%). Median NIHSS score at admission and discharge was 13 (IQR, 9–15) and 7 (IQR, 2–14), respectively (i.e. NIHSS improvement of 46.1% from baseline), (Figure 2). Two patients died in the hospital from sepsis. Similarly to group 1, none of the patients had sICH (0%). Seven patients (36.8%) had favorable outcomes at day 90, with a median mRS of 3 (IQR, 2–4).

Figure 3 illustrates the typical secondary DMVO with T13 MT in P4-PCA (calcarine artery); Figure 4 shows the additional secondary DMVO case with M4-MCA occlusion (angular artery) reperfused successfully by T13. Of the seven patients in group 3, successful recanalization was achieved in six of them (85%). Clot locations were M2 MCA and A2 ACA most commonly (both two patients, 28%), as presented in Table 3. Two patients died in the hospital due to systemic infection, one patient had non-fatal sICH.

Statistical analysis

Data was analyzed using IBM SPSS (IBM Corp, Version 27.0, NY, USA). Categorical variables were presented as frequencies and percentages, while continuous variables were presented as mean values (with standard deviation) or median values (with IQR) based on whether the data was normally distributed. The chi-square test was used to test for statistically significant differences between categorical variables. The one-way ANOVA was used to check for statistically significant differences between means of normally distributed continuous variables. On the other hand, the Kruskal-Wallis test was used to test for statistically significant differences between medians of non-normally distributed continuous variables, grouped by categorical variables. A p-value of <0.05 was regarded as being statistically significant.

Procedural complications

Seven patients (16%) had aICH; four were in group 1 (22.2%), one (5.3%) in group 2, and two (4.7%) in group 3. Convexial superficial subarachnoid hemorrhage was identified on immediate post-procedural CT imaging in two cases (4.7%), with one case reported in each of groups 2 and 3, Figure 5 demonstrates an illustrative case of peri-procedural hemorrhagic complication, identified immediately following the intervention. Overall mortality in 90 days in our cohort was documented in seven patients (16.2%). Surprisingly, most fatal cases were observed in group 3 (3/7, 42.8%), and not in group 2 which consisted also of proximal occlusions.

Discussion

Distal occlusion of intracranial arteries can cause a devastating neurological deficit.[1,4,5] The key finding of our study indicates that stent retriever thrombectomy for DMVO is not only technically feasible but also highly effective and safe. In our small cohort, successful mechanical recanalization was achieved in 86.0% (37/43) of patients undergoing DMVO procedures. Immediate clinical improvement (decrease $\geq$4 points in NIHSS after 24 h) was observed in more than 50% of the patients (median 13 decreased to nine after 24 h, up to seven on discharge), highlighting the therapy's potential efficacy in achieving rapid patient recovery.

Our results, summarized in Table 4, are compared with previously published data including the recently DMVO published RCTs, DISTAL[14] and ESCAPE MeVO,[15] demonstrating comparable recanalization and safety outcomes.

In comparison to the findings of Guenego et al.,[17] which included a cohort of 17 patients, our study demonstrated a modestly lower clinical outcome (65% vs. 39.5%, respectively); however, the median age of our patients was at least 10 years higher (i.e. much older patients), potentially influencing these outcomes.

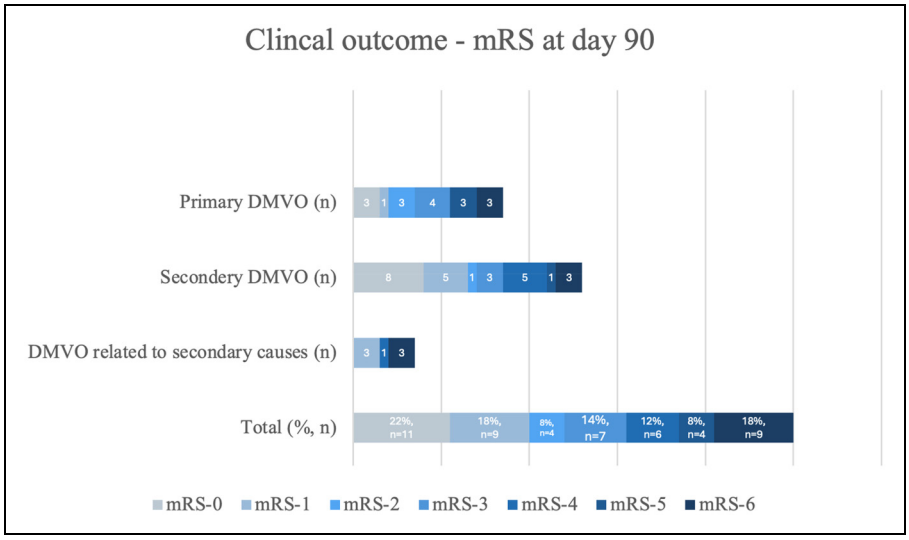

Figure 1. Clinical outcome—modified Rankin Scale (mRS) day 90.

Table 1. Baseline characteristics according to type of DMVO.

	Primary DMVO $n=17$	Secondary DMVO $n=19$	DMVO related to non-stroke procedure $n=7$	Total $n=43$	p value
Age, median (IQR)	71 (65.5–79.5)	71 (58.0–83.0)	70 (56.0–77.0)	71 (65.0–83.0)	0.456
Female sex, *n* (%)	8 (47.1)	7 (36.8)	2 (28.6)	17 (39.5)	0.666
NIHSS at admission, median (IQR)	13 (8.5–15.0)	13 (9.0–15.0)	10 (5.8–14.3)	13 (8.0–14.3)	0.918
IVT, *n* (%)	7 (41.2)	9 (47.4)	0	16 (37.2)	0.078
Anticoagulation, *n* (%)	5 (29.41)	9 (47.4)	2 (28.6)	18 (41.86%)	N.A
Hypertension, *n* (%)	12 (70.6)	10 (52.6)	4 (57.1)	26 (60.5)	0.536
Atrial fibrillation, *n* (%)	8 (47.1)	8 (42.1)	3 (42.9)	19 (44.2)	0.953
Diabetes, *n* (%)	4 (23.5)	6 (31.6)	2 (28.6)	12 (27.9)	0.865
Dyslipidaemia, *n* (%)	11 (64.7)	8 (42.1)	5 (71.4)	24 (55.8)	0.261
Smoking, *n* (%)	6 (35.3)	2 (10.5)	3 (42.9)	11 (25.6)	0.122
Ischemic heart disease, *n* (%)	8 (47.1)	9 (47.4)	4 (57.1)	21 (48.8)	0.891
Prior stroke or TIA, *n* (%)	4 (23.5)	7 (36.8)	2 (28.6)	13 (30.2)	0.682
mRS baseline, median (IQR)	1 (0.0–2.5)	1 (0.0–3.0)	1 (0.0–3.0)	1 (0.0–3.0)	0.223
Etiology					
Cardioembolic, *n* (%)	14 (82.4)	8 (42.1)	3 (42.9)	25 (58.1)	0.025
Large vessel, *n* (%)	3 (17.6)	8 (42.1)	1 (14.3)	12 (27.9)	N/A
Other, *n* (%)	0	2 (10.5)	3 (42.9)	5 (11.6)	N/A
Unknown, *n* (%)	0	1 (5.3)	0	1 (2.3)	N/A

DMVO: distal medium vessel occlusion; NIHSS: National Institutes of Health Stroke Scale Score; IVT: intravenous thrombolytic; TIA: transient ischemic attack; mRS: modified Rankin Scale; IQR: interquartile range.

Following the recent publication of the above-mentioned RCTs,[14,15] the favorable outcome rate in these studies ranged from 35% to 54%, compared to 39% in our study, indicating relatively similar clinical success rates that correlate with more established data, While the randomized prospective studies included only patients with primary DMVO, our cohort comprises patients with secondary DMVO (44.1%) as well as DMVO related to secondary causes (16.2%); only 39.5% of our patients had primary DMVO, this fact probably explain the relatively lower rate of favorable outcome in our cohort (almost half of our patients had secondary DMVO following proximal LVO). While the studies reported a recanalization rate of ~70%, our patients achieved a higher rate of 86%; this difference may be attributed to the uniform use of the dedicated device (T13) in all our patients, in contrast to the utilization of various devices in the prospective studies. In our study, no sICH was encountered in both subgroups (i.e. primary and secondary DMVOs), while in the recently published RCTs, the rate of sICH reached up to 6%.

Seven patients (16.2%) with AIS and DMVO had died within 3 months, with similar mortality rates observed between the primary and secondary DMVO subgroups

Table 2. Procedural characteristics, early and long-term outcomes.

	Primary DMVO $n=17$	Secondary DMVO $n=19$	DMVO related to non-stroke procedure $n=7$	Total $n=43$	p value
Sufficient recanalization (eTICI 2b-3), *n* (%)	14 (82.35)	17 (89.47)	6 (85.71)	37 (86.04)	0.827
Excellent recanalization (eTICI 2C-3), *n* (%)	12 (70.05)	12 (63.15)	5 (71.42)	29 (67.44)	0.985
No. of passes, median (IQR)	3 (1–5)	3 (1–4)	2 (1–4)	2.5 (1–5)	0.164
First pass, *n* (%)	1 (5.88)	1 (5.26)	1 (14.28)	3 (6.97)	0.195
GA-to-recanalization (hours), mean (SD)	1.82 (0.59)	2.2 (1.28)	2.09 (1.07)	2.04 (1.04)	0.593
Puncture-to-recanalization (hours), mean (SD)	1.23 (0.62)	1.7 (1.2)	1.52 (1)	1.5 (1)	0.294
Early outcomes					
NIHSS admission, median (IQR)	13 (8.5–15.0)	13 (9–15)	10 (5.–84.3)	13 (8–14.3)	0.632
NIHSS)24 h, median (IQR)	8 (1–12)	9 (4–14)	12 (4–15)	9 (4–12)	0.647
NIHSS at discharge, median (IQR)	6 (1–6)	7 (2–14)	8 (3–13)	7 (3–14)	0.876
Wake up stroke, *n* (%)	5 (29.41)	9 (47.36)	0 (0)	14 (32.55)	NA
In hospital mortality, *n* (%)	2 (11.8)	1 (5.3)	1 (14.3)	4 (9.3)	0.706
sICH, *n* (%)	0	1 (5.3)	1 (14.3)	2 (4.7)	0.315
aICH, *n* (%)	4 (23.5)	1 (5.3)	2 (28.6)	7 (16.3)	0.21
Hemicraniectomy, *n* (%)	0	0	0	0	NA
Infectious, *n* (%)	1 (5.9)	1 (5.3)	2 (28.6)	4 (9.3)	0.159
Procedural bleed (%)	0	0	0	0	NA
Other complications, *n* (%)	2 (11.8)	7 (36.8)	3 (42.9)	12 (27.9)	0.155
90-day outcomes					
Favourable outcome (mRS ≤ 2), *n* (%)	7 (41.2)	7 (36.8)	3 (42.9)	17 (39.5)	0.947
Excellent outcome (mRS 0-1), *n* (%)	4 (23.5)	3 (15.8)	3 (42.9)	10 (23.3)	0.35
mRS 90-day, median (IQR)	3 (1.5–5.0)	3 (2–4)	4 (1–6)	3 (2–5)	0.298
Mortality, *n* (%)	2 (11.8)	2 (10.52)	3 (42.85)	7 (16.27)	0.235

DMVO: distal medium vessel occlusion; eTICI: thrombolysis in cerebral infarction score; GA: general anesthesia; ICH: intracranial hemorrhage; sICH: symptomatic intracranial hemorrhage; asICH: asymptomatic intracranial hemorrhage; mRS: modified Rankin Scale.

(11.8% and 10.5%, respectively). This mortality rate aligns with previous reports on large vessel occlusion[20] and recently published RCTs concerning DMVO. Additionally, the largest retrospective interventional study on DMVO (115 patients) documented an in-hospital mortality rate of 18.1%.[16] It is notable that the majority of deaths in our cohort occurred among octogenarian patients (five out of seven, 71.4%), with 25% (11 out of 43) of the overall cohort being over 80 years of age. Contrary to findings reported by Rikhtegar et al.,[11] our data suggest that the T13 device may have a favorable safety profile for octogenarian patients.

In comparison to other studies on DMVO[11,17] our patients with primary DMVO presented with similar baseline characteristics, as well as comparable angiographic and clinical outcomes. To note, our cohort encompasses a broader spectrum of patients, including those receiving rescue therapy for distal iatrogenic emboli following LVO thrombectomy, as well as individuals with distal thromboembolic complications arising during elective embolization procedures.

In comparison to the findings of Rikhtegar et al.,[16] our series similarly showed no evidence of immediate or delayed vasospasm. Additionally, no patients experienced subsequent related cerebral infarction, nor required preventive or therapeutic administration of oral nimodipine.

Regarding the number of retrieval attempts, the mean for primary DMVO cases was 2.9, compared to 1.3 for secondary DMVO cases. This difference may be attributed to the time duration that the clot remained occlusive within the artery (obviously much shorter in the secondary DMVO group, probably due to recent emboli in the distal territory during the PLVO thrombectomy attempt). Of all the patients presenting with AIS (groups 1 and 2), 44.4% (16/36) received IVT prior to distal thrombectomy. Patients were classified into three categories: primary isolated DMVO (group 1); secondary DMVO following MT for PLVO (group 2); and DMVO related to thromboembolic complications during non-stroke intervention, such as aneurysm or AVM embolization (group 3). While this did not statistically affect the rate of hemorrhagic complications in our series, it is too early to conclude that prior use of IVT is safe whenever distal thrombectomy is considered. Systemic thrombolysis is significantly more effective in distal arterial occlusions; for example, in M2 segment occlusions, the recanalization rate approaches 40%, compared to ~25% in M1 segment occlusions and 8% in ICA terminus occlusions.[21] This study raises the question of the role of systemic thrombolysis in the treatment of distal arterial occlusions, specifically whether success rates are higher when combined with MT or if mechanical intervention alone suffices to

Table 3. Clot location in DMVO.

	M2	M3	M4	PICA	P2	P4	SCA	A2	A4
Primary DMVO, *n* (%)	11 (64.7)	3 (17.64)	0	0	2 (11.76)	1 (5.9)	0	0	0
Secondary DMVO, *n* (%)	5 (26.3)	4 (21.05)	2 (10.5)	2 (10.52)	1 (5.3)	0	1 (5.3)	2 (10.5)	2 (10.5)
DMVO related to non-stroke EVT procedure, *n* (%)	2 (28.57)	1 (14.3)	1 (14.3)	0	0	0	0	2 (28.6)	0
Total, *n* (%)	18 (41.86)	8 (18.6)	3 (7.0)	2 (4.7)	3 (7.0)	1 (2.3)	1 (2.3)	4 (9.3)	2 (4.7)

DMVO: distal medium vessel occlusions; SCA: superior cerebellar artery; PICA: posterior inferior cerebellar artery; EVT: endovascular treatment.
* No significant difference between the groups, *p*-value 0.335.

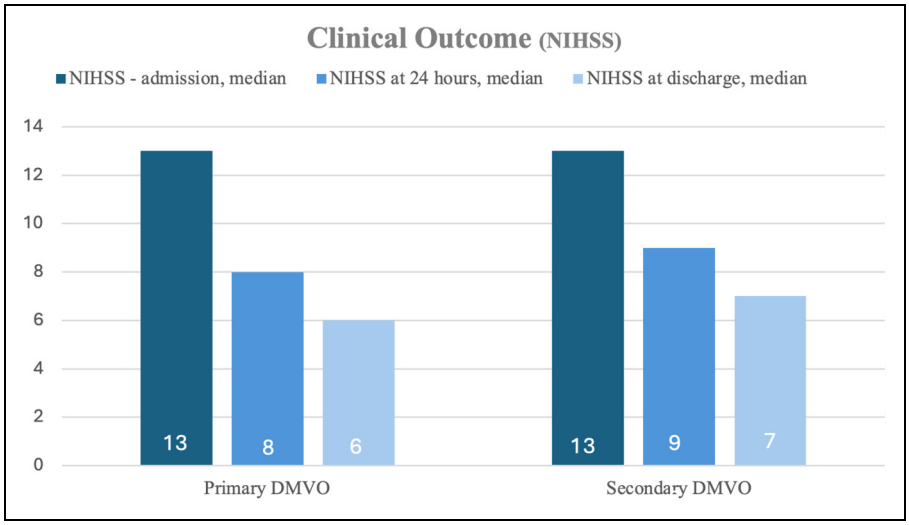

Figure 2. Clinical outcome presentation National Institutes of Health Stroke Scale Score (NIHSS). Represent the changes in NIHSS at admission versus 24 versus discharge.

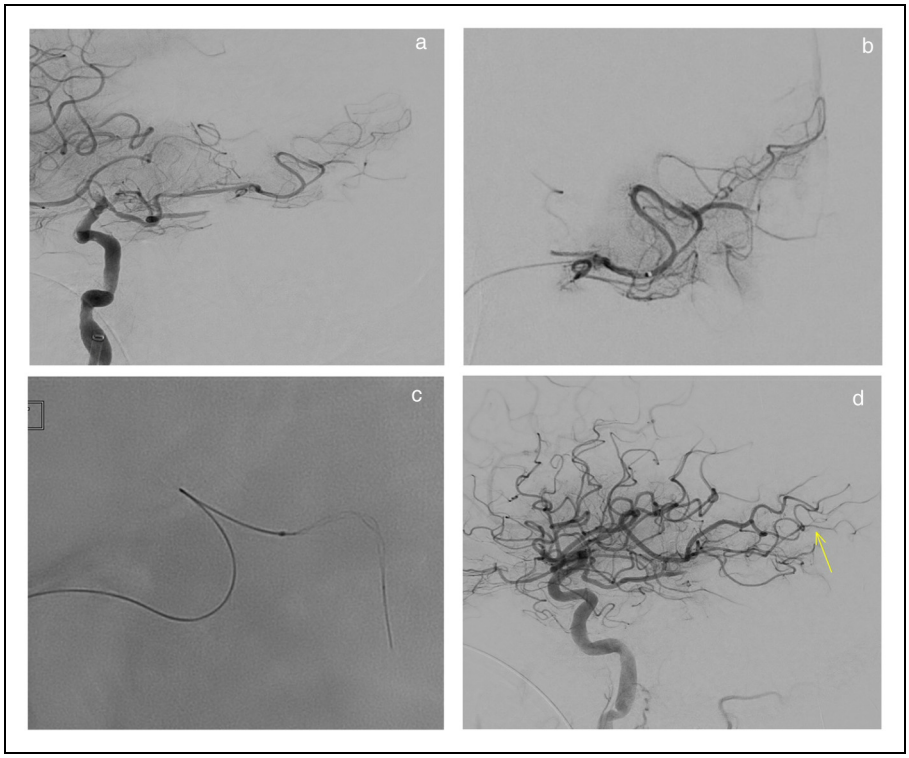

Figure 3. Reperfusion of distal PCA-P4 segment occlusion using T13 device. (a) Initial occlusion involving the calcarine artery of the fetal PCA P4 segment, following internal carotid artery T occlusion (secondary DMVO, EDT). (b) Selective PCA navigation by the Headway Duo microcatheter, followed by selective injection of contrast agent proximal to the occlusion. (c) T13 fully expanded at the level of the occlusive site. (d) Reperfusion of the occluded branch following the procedure (arrow). PCA: posterior cerebral artery; DMVO: distal medium vessel occlusions; EDT: emboli in distal territory; T13: Tigertriever13.

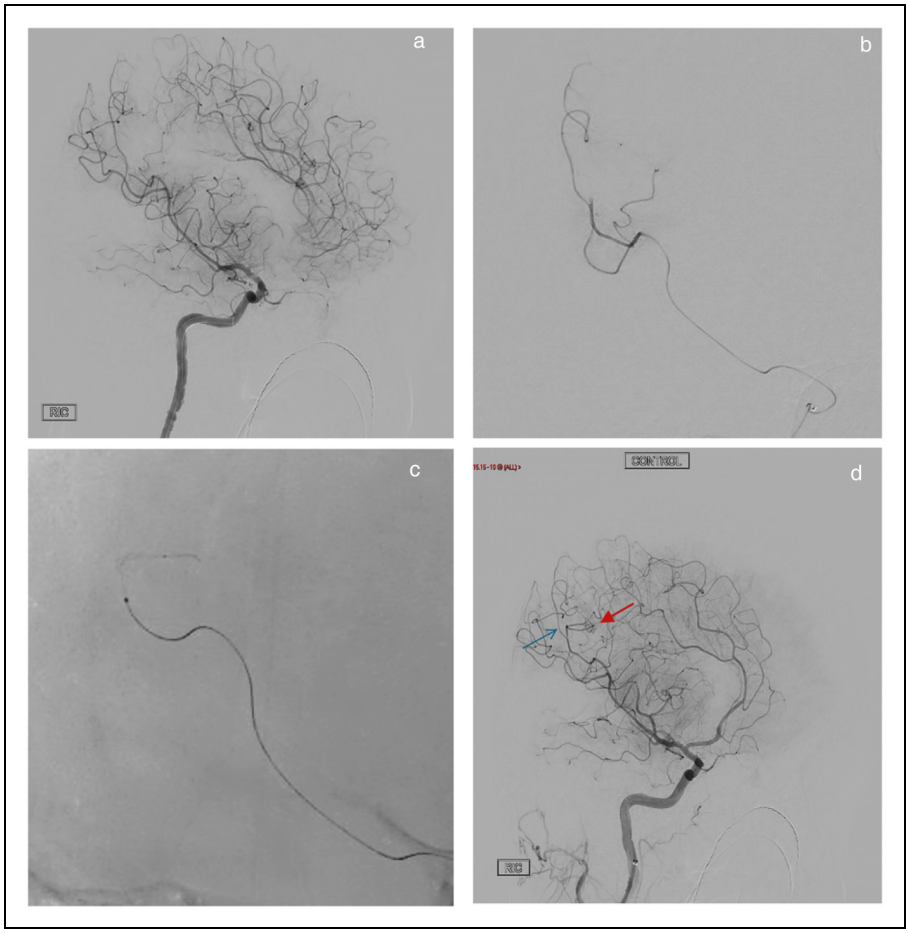

Figure 4. Reperfusion of M4 segment-angular artery occlusion using T13 device. (a) Initial occlusion involving the angular artery of the MCA-M4 segment, following M1 occlusion (secondary DMVO, EDT). (b) Selective MCA-M4 navigation by the Headway Duo microcatheter, followed by selective injection of contrast agent proximal to the occlusion. (c) T13 fully expanded at the level of the occlusive site. (d) Reperfusion of the occluded branch following the procedure (arrow). MCA: middle cerebral artery; DMVO: distal medium vessel occlusions; EDT: emboli in distal territory; T13: Tigertriever13.

minimize the risk of procedural bleeding. Recent prospective randomized controlled trials (RCTs), DISTAL[14] and ESCAPE-MEVO[15] trials, provide additional insight into the safety of combined systemic thrombolysis and MT in distal occlusions, demonstrating that the rate of symptomatic hemorrhage did not exceed 6%. In our study, T13 was impressively safe with no reported sICH.

The prospective studies reported a relatively low successful recanalization rate (71%–75%) compared to our experience (86%). It is important to note that the utilization rate of the T13 device did not exceed 2% in both studies, with other devices being used instead. In contrast, we present an experience in which T13 was used in 100% of cases. Notably, T13 is specifically designed for DMVO, differing from other devices in its engineering. It features a distal basket, which prevents distal embolization during retrieval and can be closed prior to retrieval without losing the clot, thereby reducing its diameter and minimizing intimal injury during retrieval, we await the publication of the DISTALS trial[22] results (NCT05152524), which focused exclusively on the use of T13 for distal occlusions, to elucidate the level of safety and efficacy in comparison to other existing devices.

In our study, the median number of T13 passes was found to be 2 (1–5) for all patients, with a median of 1 (1–3) for secondary DMVO, and 3 (1–5) for primary DMVO.

The first pass effect (FPE) plays a pivotal role in MT for AIS, as achieving complete or near-complete recanalization on the initial attempt has been associated with improved clinical outcomes, reduced procedure times, and lower rates of complications.[23] The overall FPE rate in our cohort was 34.8%, with a notably lower rate in primary DMVO patients compared to those with secondary DMVO (5.8% vs. 68.4%, respectively). These findings underscore the challenges presented by the prolonged persistence of emboli within the artery in primary DMVO, which complicates the retrieval process and extends the duration of the procedure.

MT of distal cerebral arteries is inherently complex and should be performed exclusively by experienced neuro-interventionalists in high-volume centers. This requirement is particularly critical for the use of the T13 device, which involves a distinct learning curve that differs from that of traditional stent retrievers. Proficiency with this device is crucial for optimizing patient outcomes and minimizing procedural complications.

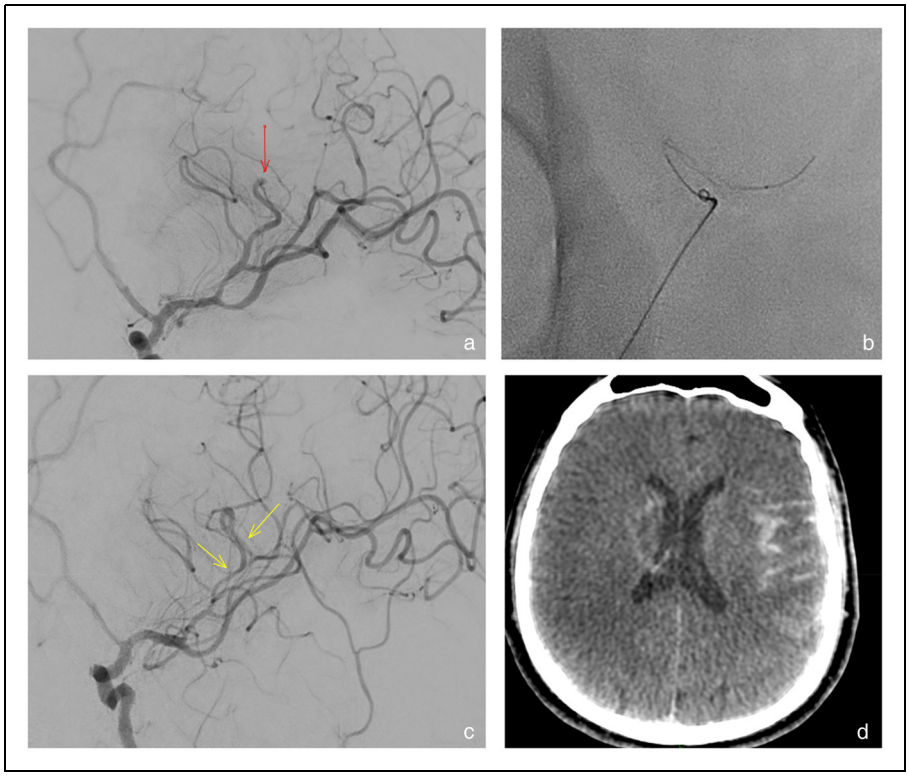

Figure 5. Distal thrombectomy of the M3 segment resulted in iatrogenic asymptomatic convexial SAH. (a) Proximal M3 segment occlusion of a precentral frontal branch (arrow), following LVO with tandem LICA occlusion. (b) T13 device deployed and fully expanded within the occluded M3 angular segment. (c) Complete reperfusion (TICI 3) was achieved after a single thrombectomy pass using the T13 device. (d) Immediate post-procedural non-contrast CT demonstrating a superficial convexial SAH, most probably iatrogenic secondary to a partially opened state of the T13 device while retrieval. SAH: subarachnoid hemorrhage; LVO: large vessel occlusion; LICA: large internal carotid artery; TICI: thrombolysis in cerebral infarction; CT: computed tomography; T13: Tigertriever13.

The primary limitations of this study stem from its retrospective design, which carries inherent biases. Additionally, self-assessment of imaging results, without core laboratory validation, may affect result consistency. Various confounding factors also limited our ability to correlate angiographic data with long-term clinical outcomes, which were unavailable in this study. Nevertheless, we utilized the 24-hour NIHSS and day 90 as surrogate markers, which is generally considered a reasonable alternative. Another concern involves the learning curve associated with the T13 device and the potential for excessive mesh expansion during clot retrieval, which could elevate hemorrhagic risk compared to conventional stent retrievers, although it is assumed that the device generates higher radial forces due to its manual operation via controlled expansion, this concern is not reflected in the clinical outcomes observed in our study. Specifically, the procedural safety profile demonstrated no evidence of intraprocedural complications such as hemorrhage, dissection, or vasospasm, underscoring the safety and efficacy of the device in our cohort.

Another limitation of our study, similar to previous works, lies in the absence of a standardized and validated scoring system for assessing the degree of recanalization in distal occlusions. Although a position paper[5] has been published proposing a potential scoring system, it has yet to undergo validation.

Despite these limitations, the findings suggest that the T13 device may enhance rates of total or subtotal recanalization in patients with primary or secondary DMVO, without a significant increase in symptomatic hemorrhagic complications.

The recent editorial by Mocco[24] refines the conclusions of recently published RCTs[14,15] regarding the limited clinical benefit of thrombectomy, highlighting potential selection bias, technical limitations, lower recanalization rates, and procedural delays, including increased anesthesia use. These factors may have influenced outcomes, necessitating further research with refined methodologies to optimize therapeutic strategies for medium and distal vessel occlusions. Similar to early LVO trials, which initially faced methodological criticism, subsequent large RCTs rapidly overturned initial conclusions and have shaped treatment guidelines for the past decade.

In summary, our study demonstrates the promising potential of stent retriever thrombectomy for distal middle vessel occlusions, highlighting its technical feasibility and effectiveness in achieving favorable clinical outcomes. The T13 device exhibits a favorable safety profile, particularly in older patients, while addressing a diverse range of occlusion sites. These findings underscore the need for further research into the integration of systemic thrombolysis with MT, which could enhance treatment strategies for AIS.

Table 4. Comparative analysis of our experience versus current published data.

	Journal, year	Number of patients (*n*)	Age (median, IQR)	Primary DMVO (*n*)	Secondary DMVO (*n*)	Successful recanalization (%)	Number of passes (median, IQR)	FPE (%)	sICH, (*n*, %)	Procedural bleed (*n*, %)	Favorable outcome (mRS ≤ 2), (*n*, %)	Mortality, (*n*, %)
Rikhtegar et al.[16]	JNIS 2020	115	77 (NA)	34	71	74.7%	1 (1–5)	NA	2 (1.7%)	NA	24[a] (65%)	19 (18.1%)
Guenego et al.[17]	INR 2021	17	60 (50–65)	11	6	94%	2 (2–3)	NA	0	1 (6%)	11 (65%)	1 (6%)
Gruber et al.[18]	INR 2020	30	72.5 (64–79)	NA	NA	94%	1 (1–2)	24%	1 (3%)	NA	25 (83%)	3 (10%)
Fischer et al.[19]	INR 2021	43	77 (NA)	32	13	84.4%	1 (1–2)	26.7%	3 (7%)	1 (2.3%)	25 (83%)[b]	NA
Goyal et al.[15c] ESCAPE-MeVO trial	NEJM 2025	255	74 (63–82)	255	0	75.1%	NA	NA	14 (5.4%)	1 (0.4%)	138 (54.1%)	34 (13.3%)
Psychogios et al.[14] DISTAL trial	NEJM 2025	229	77 (68–83)	271	0	71.7%	NA	NA	16 (5.9%)	8 (3%)	94[d] (34.7%)	42 (15.5%)
Our cohort	**2025**	**43**	**71 (65–83)**	**17**	**19**	**86%**	**2 (1–3)**	**6.9%**	**0**	**0**	**17 (39.5%)**	**7 (16.27%)**

NA: non-available; JNIS: Journal of Neuro-Interventional Surgery; INR: interventional neuroradiology; Successful recanalization: Tici2b-3; FPE: first pass effect; sICH: symptomatic intracranial hemorrhage; mRS: modified Rankin Scale.

[a]Final clinical data include 38/115 (33%) of patients.

[b]Final clinical data include 30/43 (70%) of patients.

[c]Most patients were treated with the Solitaire X family device, with no data on Tiger 13 use.

[d]Data reported included only mRS 0-1.

Conclusions

Direct or rescue thrombectomy for distal medium vessel occlusions using a T13 device demonstrates high recanalization rates with a low incidence of symptomatic hemorrhagic complications. Despite the recent landmark RCTs that have questioned the clinical advantage of MT over conservative management in distal occlusions, our results challenge these findings. This discrepancy is highlighted by our cohort's higher recanalization rates and the absence of sICH complications, in contrast to the outcomes reported in these trials. Notably, favorable outcome rates and mortality in our study remained comparable to those observed in the recent RCTs. Further RCTs (such as ongoing DISTALS trials) utilizing dedicated low-profile, distal basket-like mechanical devices are warranted to delineate optimal therapeutic strategies for medium and distal vessel occlusions, to enhance angiographic success rates, and, consequently, clinical outcomes.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

This study involves human participants and was approved by a local Ethics Committee: IRB – Rabin Medical Center, 0793-21.

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ORCID iDs

Chen Meir Kadosh https://orcid.org/0009-0007-0523-3267
Johnatan Naftali https://orcid.org/0000-0003-2251-8663
Keshet Pardo https://orcid.org/0000-0001-5056-2368
Rani Barnea https://orcid.org/0000-0003-4741-2486
Guy Raphaeli https://orcid.org/0000-0002-4098-517X

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