Original Research Article

INR INTERVENTIONAL NEURORADIOLOGY

Interventional Neuroradiology
1–10

DOI: 10.1177/15910199231222667
journals.sagepub.com/home/ine
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Radially adjustable stent retriever for mechanical thrombectomy in acute ischemic stroke: Improved first-pass effect with rapid-inflation deflation technique

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Abstract

Introduction: Evidence for improved first-pass effect with the novel radially adjustable radio-opaque stent retriever Tigertriever is lacking.

Objective: To compare improvement in first pass success with Tigertriever using two different techniques—rapid inflation deflation (RID) and suction thrombectomy (ST).

Methods: Retrospective analysis of patients with acute ischemic stroke who underwent mechanical thrombectomy with Tigertriever at a single comprehensive stroke center.

Results: Thirty patients were included. Mean age was 72.8 years. Twelve patients (48%) experienced successful first passes with Tigertriever. Successful revascularization (modified thrombolysis in cerebral infarction (mTICI) 2b/3) was achieved in all (100%) patients who received RID or ST technique for thrombectomy. Good clinical outcome (modified Rankin score = 0–2) was noted in 40% (n = 10). Total mortality in the cohort was 8% (n = 2). RID and ST groups comprised of 10 and 15 patients, respectively. Five patients underwent MT with Tigertriever as a rescue device.

RID vs ST: No difference was noted in mean age (p = 0.27), gender (p = 0.29), location of occlusion (p = 0.46), and device used for first pass (p = 0.57). A 70% first-pass success rate in RID group and 37.5% in ST group was noticed (p = 0.06). Mean time from groin puncture to reperfusion (TICI 2b//3) was statistically similar (p = 0.29, RID: 19.9 min vs ST: 25 min). Both groups noted a 100% complete recanalization rate. The rate of mortality between the two groups were not statistically different (p = 0.46).

Conclusion: The preliminary first-pass success rates of RID technique with Tigertriever compared to ST technique, are encouraging. Longitudinal studies with longer follow up are needed to elucidate the smaller learning curve with this device.

Keywords

Mechanical thrombectomy, Tigertriever, rapid inflation-deflation, first-pass effect

Received 17 September 2023; accepted 21 November 2023

Introduction

Innovation in endovascular technology has improved outcomes in acute ischemic stroke (AIS), provided the correct device is used with an appropriate technique.[1,2] The MR CLEAN study established a role for mechanical thrombectomy (MT) in addition to intravenous thrombolysis, in patients with large vessel occlusion of anterior circulation.[3] In spite of technological advances, the angiographic success reported is 55% to 80%.[4] The first-generation stent retrievers achieved a modest successful reperfusion rate (70%).[5] Apart from experience of neuro-interventionalist, the type of device and technique used have emerged as important contributors in improving patient outcomes. The Tigertriever (Rapid Medical, Yokneam, Israel) is a novel, radially adjustable, fully visible stent retriever that aligns radially with target vessel diameters and increases the integration with thrombus. This facilitates easy complete clot retrieval and reduces distal embolization. European Commission mark approval for the device was obtained in 2016 and Food & Drug Administration approval in April 2021.[5] In this comprehensive stroke

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center spectrum of patients with AIS, we compare the outcomes of rapid inflation deflation (RID) technique with standard suction thrombectomy (ST) with the Tigertriever used for first pass in MT. In cases where a failed first-pass attempt with another device was observed, Tigertriever was used as rescue device.

Materials and methods

Treatment methodology

At our comprehensive stroke center, between February 2022 and March 2023, patients who underwent MT for AIS using a Tigertriever were screened retrospectively (patient distribution flowchart in Figure 1). The inclusion criteria for patients to undergo MT were a last known well of within 24 h and National Institute of Health Stroke Scale score (NIHSS) of 8 to 29 and diffusion restriction volume < 50 ml, for any circulation stroke. Intravenous recombinant tissue plasminogen activator (IV rtPA) (0.9 mg/kg) was administered for patients suitable for IV thrombolysis within 4.5 h of onset. General anesthesia was used in all patients. The modified thrombolysis in cerebral infarction (mTICI) score of 2b/3 was considered as successful revascularization. This was determined by the physician performing the MT.

All procedures were performed on a biplane flat panel digital subtraction angiography unit (GE). A 6F introducer (Penumbra) was placed in the right femoral artery. Diagnostic runs using a 5F catheter were used to demonstrate the site of occlusion. The 5F catheter was exchanged for a 6F guide catheter over a 0.035” guidewire. Depending on circulation affected, the guide catheter was placed in the internal carotid (ICA) or vertebral

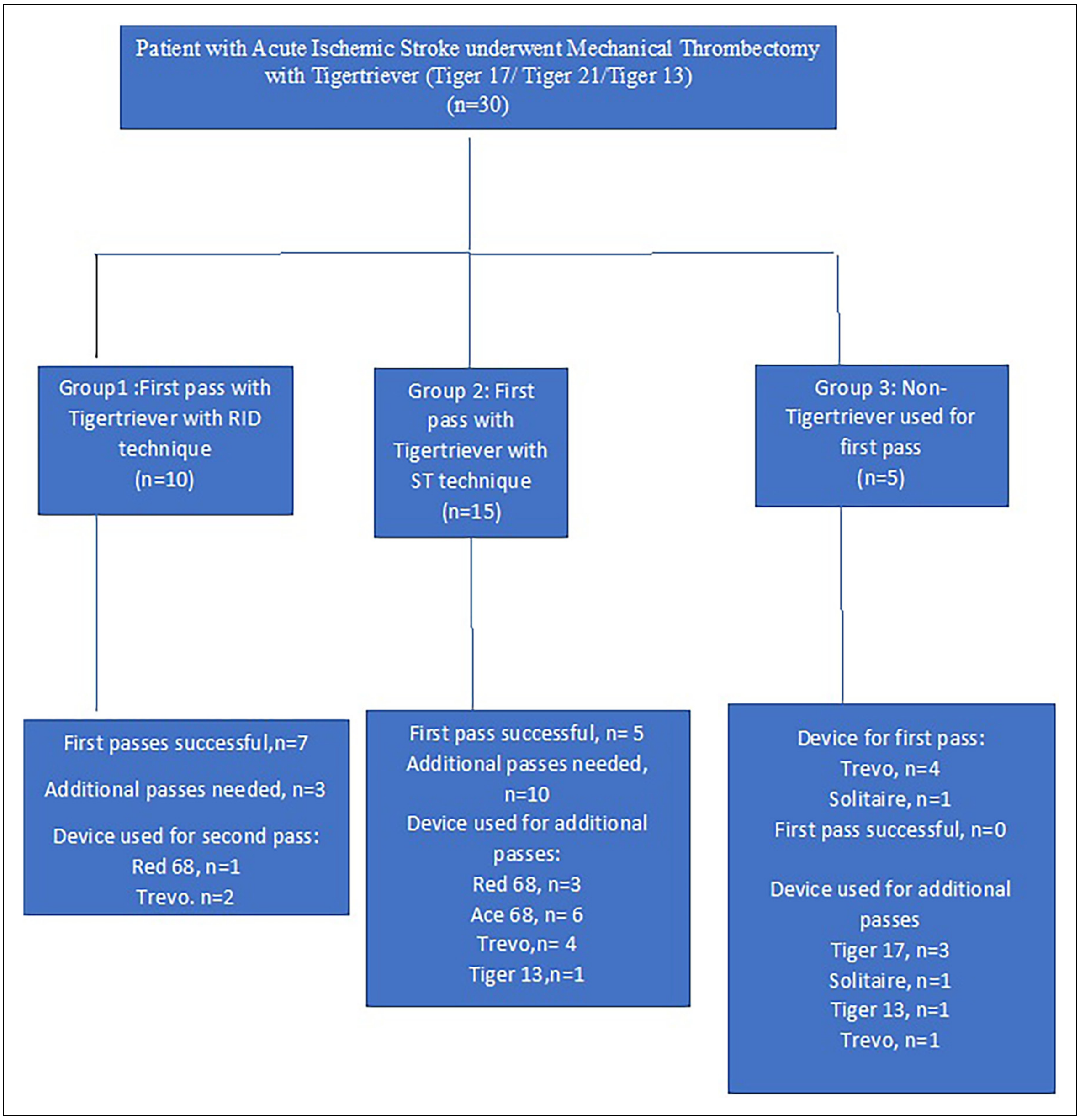

Figure 1. Flowchart of patient distribution in the study.

artery (VA). The occluded segment was bypassed using a microcatheter over a 0.014" micro guidewire. The position of microcatheter was then verified with a contrast run. The microcatheter was gradually withdrawn to unsheath the retriever. The active suction microcatheter remains positioned proximally to the retriever, while performing MT.

Device structure and mechanism

There are 3 versions of Tigertriever. First, the standard Tigertriever 21 is delivered through a 0.021″ microcatheter and second Tigertriever 17, is delivered through a 0.017″ microcatheter. Finally, Tigertriever 13, the smallest version, is designed for reaching distal occlusion sites.[4,6] Tigertriever 17 has an unexpanded net length of 23 mm and can be expanded to a diameter of 3 mm. Tigertriever 21 has a net length of 32 mm and can be expanded to a diameter of 6 mm. The key features which distinguish Tigertriever from other devices are: (1) manual control of expansion and deflation and (2) completely radio-opaque nature. Tigertriever 13 has demonstrated good revascularization outcomes in distal medium vessel occlusion according to some recent studies.[7]

Manual control of device

With tigertriever, the physician achieves newer degrees of freedom in the form of extent of device exposed to the clot, degree of expansion during clot integration, speed of expansion, degree of expansion during clot retrieval, and insertion into guide catheter (Figure 2). The last one is essential to minimize risk of embolization to new territory (ENT).

Radio-opacity

Nitinol has limited intrinsic radio-opacity. A standard nitinol stentriever is not visible on a routine fluoroscopy. Addition of platinum to nitinol base enhances the radio-opacity of each wire. Radio-opaque markers are located along the proximal and distal end of device. This fluoroscopic visibility contributes to various degrees of freedom.

Use of Tiger 17 or Tiger 21

The choice between Tiger 17 or Tiger 21 depended on physician judgment of the vessel caliber and location of occlusion. Proximal occlusions, for example, ICA (Figure 3) or VA, vertebrobasilar junction occlusion may be tackled with Tiger 21 while middle cerebral artery (MCA) (Figure 4), anterior cerebral artery, or posterior cerebral artery occlusions may need Tiger 17.

Techniques of MT using Tigertriever

Standard suction thrombectomy technique (ST). After unsheathing the device, under roadmap guidance, the device is slowly expanded to appose with vessel wall. After waiting for 2 to 3 min, the device is partially deflated and slowly withdrawn. The extruded device checked for presence of clot and a confirmatory angiography run performed after first pass.

Rapid inflation–deflation technique. The Tigertriever was deployed so that proximal 1/3 of the device covered the proximal part of the clot after unsheathing. Then it is rapidly inflated and deflated 20 to 30 times in a span of few seconds. Once completed, the stent retriever is partially deflated and withdrawn via the microcatheter and subsequently examined for presence of clot. A successful first pass is confirmed with a diagnostic angiography run.

The choice of technique (RID vs ST) was physician dependent. Some physicians were comfortable using the ST method while some graduated to using the RID method with ease. A proximal suction microcatheter was used routinely by all attending endovascular physicians as a triaxial system while performing mechanical thrombectomy. Other devices used as a rescue after failed first-pass attempts with Tigertriever, were Trevo (Stryker Neurovascular, CA, USA), Ace 68 (Penumbra, Inc., Alameda, CA, USA), Red 68, Tiger 17.

Follow up

Imaging with computerized tomography was performed at 24 h (routinely) and when deemed necessary in post-operative period, to assess for intracranial hemorrhage (ICH), completed infarct or any other complications. Modified Rankin Scale (mRS) scores were obtained at 24 h and latest clinical follow up after discharge.

Group stratification

Three groups of patients with AIS treated with MT were identified retrospectively—group 1 (RID technique with aspiration), group 2 (ST technique with aspiration), and group 3 where Tigertriever was used as rescue device after failure of another device.

Data collection

Demographic parameters like age, gender, National Institute of Health Stroke Scale (NIHSS) score, comorbidities like diabetes (DM), hypertension (HTN), coronary artery disease (CAD), hyperlipidemia, lymphoma, previous coronary artery bypass grafting (CABG), location of occlusion, perfusion mismatch ratio, size of ischemic core, penumbra, time of last normal, rtPA received, time of groin puncture, time to reperfusion (TICI 2b/3), number of passes, devices used for different passes, intra-procedural complications, pre-operative and postoperative NIHSS, mRS score, neurological morbidity and mortality were documented on Microsoft Excel 2019. Clinical status was indicated by the mRS score with improvement considered when a patient migrated from poor level score

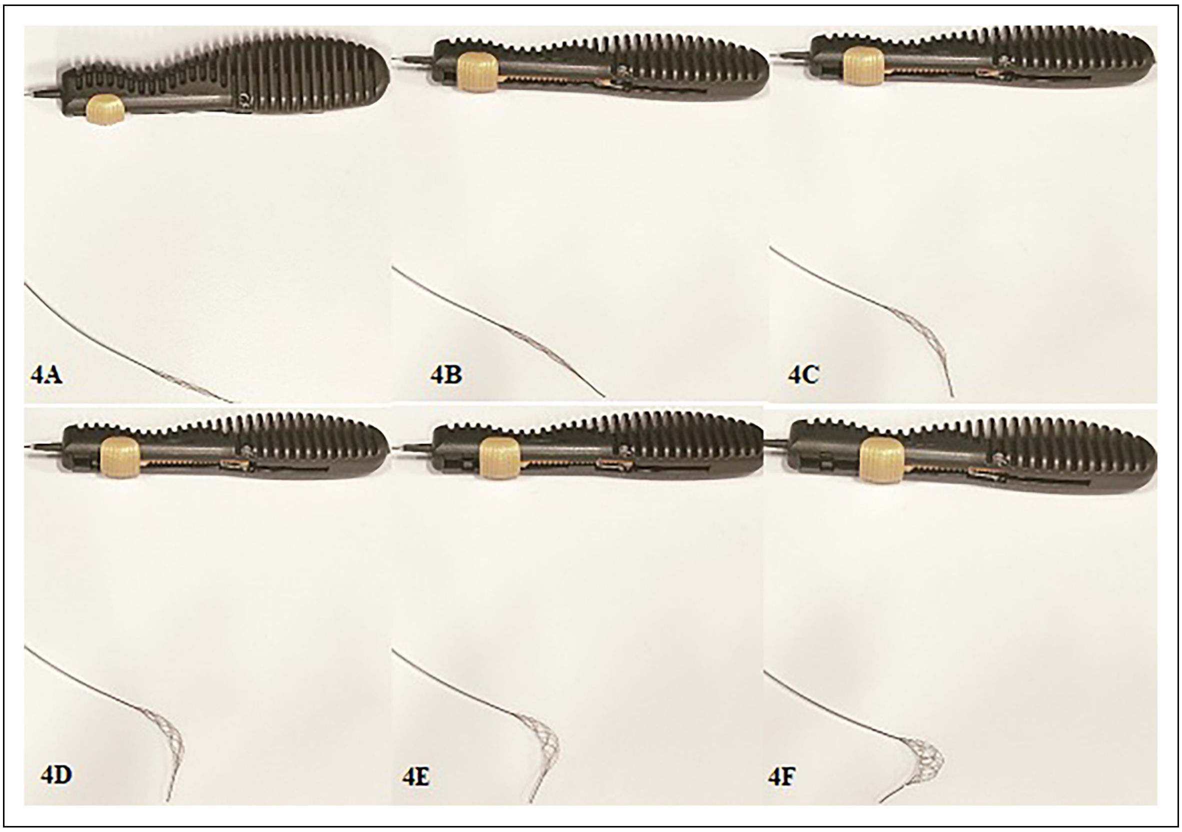

Figure 2. Mechanism of Tigertreiver expansion and deflation. (A) Completed deflated stent with outermost position of the slider. (B) Partial expansion of the stent with slider position two clicks backwards. (C)–(E) More expansion of the stent with slider position further backwards. (F) Completed expanded stent with innermost position of the slider.

(mRS 5–6 or 3–4) to good level score (3–4 or 0–2, respectively).

Statistical analysis

Unpaired t test was used to compare demographic parameters between RID and ST groups. Outcomes were compared using Fischer's exact test. All analysis was performed using STATA/BE statistical package version 17.0 (StataCorp). A p value <0.05 was considered statistically significant.

Results

Results in the combined cohort

Demography. The mean age of 30 (n) patients was 69.06 (±4.1) years. There were 13 males and 17 females. Comorbidities were DM in 15, HTN in 21, CAD in 13, hyperlipidemia in 26, previous CABG in 1, history of lymphoma in 1. MCA (n = 21) was the most common location of occlusion followed by ICA (n = 3), vertebrobasilar (n = 4), and combined occlusion of ICA and MCA (n = 3).

Outcomes. The mean NIHSS score was 14.35 (median 13, SD 7.3); mean ASPECT score 8.2 (median 8, SD 0.9), and mean mRS at admission was 2.91 (median 3, SD 1.3). Seven patients received IV rtPA. A revascularization score of mTICI 2b/3 was attained in 96.7% (n = 30) patients while the remaining patient reached mTICI 2a score. Successful first-pass effect (FPE) was observed in 45.1% (n = 14) cases. Mean follow-up duration was 78.1 days (median 76, SD 12.6). Clinical improvement in mRS score was noted in 35.5% (n = 11) while no change in mRS was observed in 41.9% (n = 13) patients. Mean mRS at follow up was 3.29 (median 4, SD 1.8). A good clinical outcome (mRS 0–2) was seen in 11 (35.4%) patients. Total mortality in the cohort was 6.4% (n = 2). No vessel rupture, device detachment, or dissection of parent vessel was observed.

RID versus ST group comparison

No difference was noted in mean age (p = 0.23), gender (p = 0.29), location of occlusion (p = 0.60), and device used for first pass (p = 0.74). The median NIHSS score was 13 in RID group and 12.25 in ST group (p = 0.18) (Table 1). The FPE rate in RID group was 70% (n = 7) and 37.5% in ST group (p = 0.06). Both groups noted a 100% complete recanalization rate (TICI 2b/3). Improvement in neurological status (mRS score) was documented in 40% (n = 4) in RID group and 33.3% (n = 5) in ST group at a mean follow up of 66.7 and 91 days, respectively. No change in mRS score was noticed in 44.4% (n = 4) in RID group and 46.6% (n = 7) in ST group. Follow-up

Figure 3. Use of Tigertriever for mechanical thrombectomy along the ICA. (A) Proximal ICA as the site of occlusion (red arrow) as seen on a lateral angiogram projection. (B) Anteroposterior angiogram projection showing proximal ICA as the site of occlusion (red arrow). (C) Unsubtracted anteroposterior angiogram image showing positioning of the Tigertriever device in an expanded fashion (red arrow). (D) Unsubtracted lateral angiogram image showing positioning of the Tigertriever device in an expanded fashion (red arrow). (E) Successful revascularization demonstrated by mTICI 2b score on a lateral angiogram projection. Note is made of the atherosclerotic narrowing in the ICA segment (red arrow) at the level of occlusion. (F) Anteroposterior angiogram projection demonstrating mTICI 2b score of successful revascularization. ICA: internal carotid artery; mTICI: modified thrombolysis in cerebral infarction.

duration was not statistically different ($p = 0.32$) between these two groups. Mean mRS at follow up was not statistically different (2.6 in RID vs 3.6 in ST, $p = 0.46$).

In RID group, where FPE with Tiger 17 or 21 was not successful, devices used for rescue were Trevo ($n = 1$) and Red 68 aspiration catheter with Trevo ($n = 1$). In ST group, rescue devices for remaining passes were Red 68 ($n = 2$), Ace 68 ($n = 6$), Trevo ($n = 3$), and Tiger 17 ($n = 3$).

Complications. Mortality was observed in two patients in postoperative period. One patient with MCA occlusion across M2 and M3 segments had ASPECT score 7, NIHSS score 20, and poor pre-operative mRS (score 5), underwent successful revascularization (TICI 2b) with Tiger 17 (ST technique) for first pass and Ace 68 for second pass. This patient succumbed to atrial fibrillation with rapid ventricular rate in postoperative period. Another patient with prior lymphoma history and a left P1-P2 posterior cerebral artery occlusion with ASPECT score 9 and NIHSS score 15, underwent MT with RID technique of Tiger 17 for first pass and Trevo for second pass. This patient developed a left thalamic hemorrhage with intraventricular hemorrhage in the postoperative period and succumbed on POD3. The cause of hemorrhage could not be attributed to rapid revascularization, lymphoma-induced bleeding susceptibility or perforator vessel injury. Mortality rate between the two groups was not statistically different ($p = 0.46$).

Worsening of neurological status despite revascularization was observed in two patients in RID group and three in ST group. Symptomatic hemorrhagic transformation was noticed in one patient in RID group. Two patients in each group developed completed infarct, on postprocedure imaging. Asymptomatic hemorrhagic transformation was noticed in one patient in RID group and two in ST group.

Group 3: Tigertriever as a rescue device

This group comprised of patients where Tigertriever was used for rescue thrombectomy (rescue subgroup, $n = 5$) (Table 2). The device used for the first pass was Solitaire in one patient and Trevo in 4. Tiger 17 was used for rescue thrombectomy with RID technique ($n = 2$) and ST technique ($n = 3$) patients. The choice of technique was dependent on the physician. Mean NIHSS score was 14.8 (median 13), mean ASPECT score was 7.6 (median 8), and mean mRS score at admission was 5. IV thrombolysis with rtPA was given in one patient. The median time from last well-known to groin puncture was 171 min, mean time from groin puncture to reperfusion was 25 min (median = 25 min). Mean mRS at follow up was 3.4. Improvement in functional

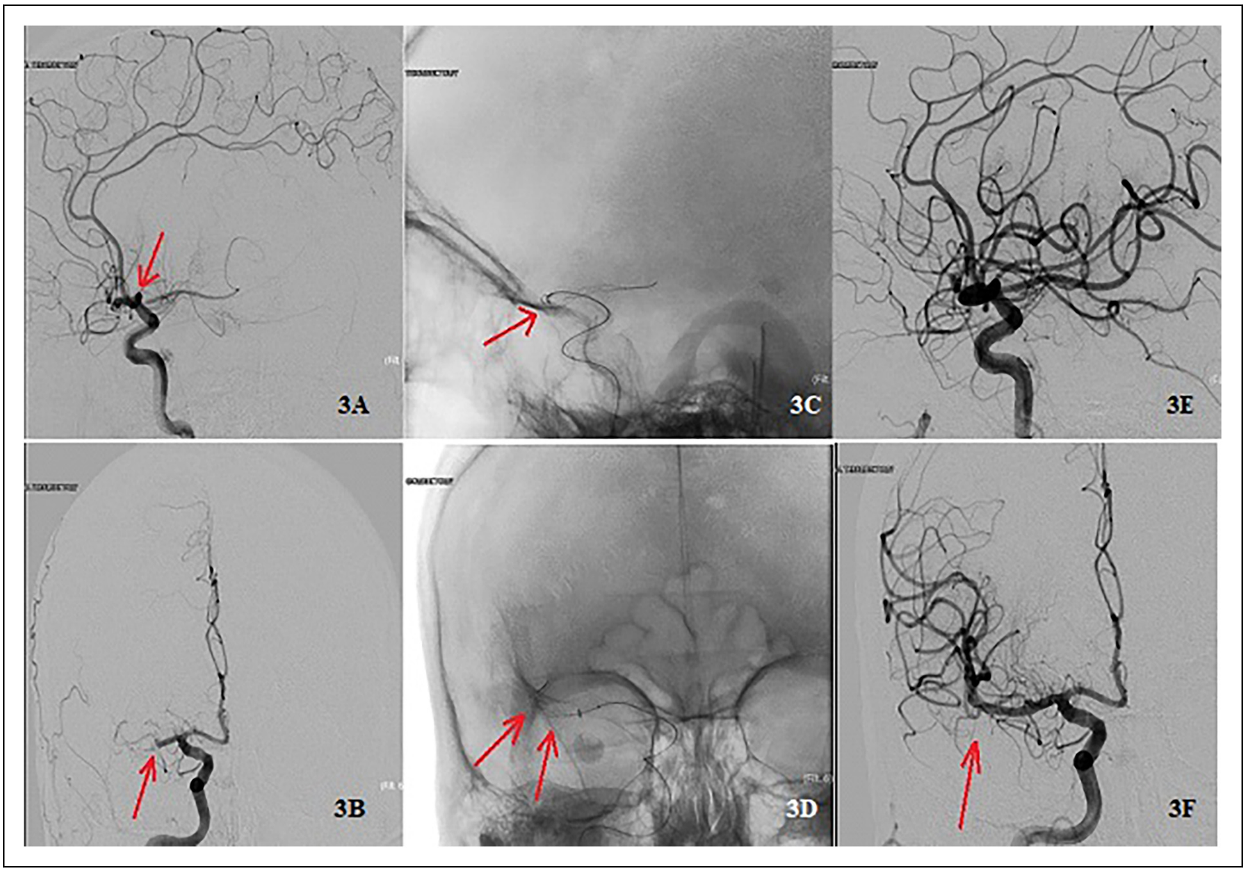

Figure 4. Use of Tigertriever for mechanical thrombectomy along the MCA. (A) Proximal MCA as the site of occlusion (red arrow) as seen on a lateral angiogram projection. (B) Anteroposterior angiogram projection showing proximal MCA as the site of occlusion (red arrow). (C) Unsubtracted lateral angiogram image showing positioning of the Tigertriever device in an expanded fashion (red arrow). (D) Unsubtracted anteroposterior angiogram image showing positioning of the Tigertriever device in an expanded fashion (red arrow). (E) Successful revascularization demonstrated by mTICI 3 score on a lateral angiogram projection. (F) Anteroposterior angiogram projection demonstrating mTICI 3 score after successful revascularization. MCA: middle cerebral artery; mTICI: modified thrombolysis in cerebral infarction.

status (mRS score) was seen in 80% (n = 4) patients. Although no mortality was reported in this subgroup, worsening neurological status was seen in one patient with a completed infarct. Asymptomatic hemorrhagic transformation was seen in one patient and new onset pontine infarct was seen in one patient with primary vertebro-basilar ischemic stroke.

Complications. One patient who underwent a successful (TICI 3) primary thrombectomy with Trevo for first pass and Tiger 17 for second pass developed a completed infarct with hemorrhagic transformation. This patient had a poor neurological status (mRS score 5) with right lower limb deep vein thrombosis in the postoperative period. Identifying the risk factors for Deep Vein thrombosis and providing adequate venous thromboembolism prophylaxis is important to reduce morbidity and mortality associated with the disease.[5,6]

Discussion

Although the usage of Tigertriever has been increasing recently, the optimal technique remains elusive. The limited literature on different techniques include a standard unsheathing method which was compared with the RID method by Kara et al.[4] The former method involves introduction of the Tiger device at the site of occlusion, gradual unsheathing of the device by pulling the microcatheter, slow expansion of the mesh to integrate with the clot, waiting for 4 min, partial deflation of mesh, insertion of stent retriever mesh into the microcatheter while withdrawing it from the site of occlusion. The use of suction along with stent retriever was not demonstrated in this study. The first technique used by Kara et al. was an “unsheathing” only technique while our comparator with RID group was a ST technique where we use a suction microcatheter proximal to the stent retriever. At our center, most practitioners used the Tiger device at the occlusion site along with a continuous suction microcatheter. It has been noted that distal vessel occlusion may benefit by refining the operation steps. This rapid inflation–deflation technique is believed to cause faster and complete thrombus integration. Hence, data regarding efficacy and safety of rapid inflation–deflation technique (RID) remains elusive. In contrast to the study published by Kara et al., our study also highlights the use of Tigertriever as a rescue thrombectomy device in a subgroup of patients.

Table 1. Comparison of mechanical thrombectomy for acute ischemic stroke by RID versus ST technique.

	Group 1 (n = 10) RID	Group 2 (n = 15) ST group	
Mean age	72.6 ± 13.6 years	73 ± 13.92 years	P = 0.23
Gender	M = 3, F = 7	M = 8, F = 7	P = 0.29
Comorbidity			
DM	5	9	P = 0.20
HTN	7	12	
CAD	7	4	
Hyperlipidemia	8	14	
Location of occlusion	ICA = 1 MCA = 6 VA-BA = 1 PCA = 1 ICA + MCA = 1	ICA = 2 MCA = 11 VA-BA = 1 PCA = 0 ICA + MCA = 1	P = 0.60
Median ASPECT score	9	8	P = 0.26
Mean NIHSS	16 (± 8.5)	10.5 ± 6.25	P = 0.18
Median NIHSS	13	12.25	
IV rtPA before thrombectomy	3	3	
Device used for first pass	Tiger 17, n = 9 Tiger 21, n = 1	Tiger 17, n = 13 Tiger 21, n = 2	P = 0.74
Median time from last well known to groin puncture (min)	437	472	
Mean time from groin puncture to reperfusion (TICI 2b/3) (mins)	19.90	25	P = 0.29
First pass success	7 (70%)	5 (37.5%)	P = 0.06
Multiple passes needed	3	10	
Successful revascularization	10 (100%)	15 (100%)	
Mean mRS at follow up	2.6	3.6	P = 0.46(unpaired t test)
Median mRS at follow up	2	4	
Median follow up duration (range = 1–90 days)	63	89	P = 0.32
Mean follow-up duration	66.7	91.75	
Good clinical outcome (mRS = 0–2) at follow-up	6 (60%)	4 (26.6%)	
Improved Neurological Status	4 (40%)	5 (33.3%)	
No change in mRS at follow up	4 (44.4%)	7 (46.6%)	
Worsened neurological status	2 (22.2%)	3 (20%)	
Mortality at 3 month	1(11.1%)	1(6.6%)	0.46
symptomatic hemorrhagic transformation	1 (11.1%)		
Completed infarct	2 (22.2%)	2 (13.3%)	
Asymptomatic hemorrhagic transformation	1 (11.1%)	2 (13.3%)	

BA: basilar artery; CAD: coronary artery disease; DM: diabetes; HTN: hypertension; ICA: internal carotid artery; MCA: middle cerebral artery; mRS: modified Rankin score; NIHSS: National Institute of Health Stroke Scale; PCA: posterior cerebral artery; rtPA: recombinant tissue plasminogen activator; RID: rapid inflation deflation; ST: suction thrombectomy; TICI: thrombolysis in cerebral infarction; VA: vertebral artery.

A similar method called "push and fluff" technique was described by Haussen et al. for maximal expansion of TREVO. They achieved better results than a standard suction technique.[8] The theoretical explanation for better clinical results was increased stent–clot integration due to an increased radial force, higher wall apposition, increased cell size, and optimized cell configuration.

First-pass effect

The TIGER (Treatment with Intent to Generate Reperfusion) trial demonstrated an FPE of 57.8% while successful FPE of as low as 24% was documented by Gruber et al.[9,10] In our retrospective review, the FPE of 70% was observed in RID group and 37.5% in the ST group. Although we did not achieve statistical significance (p = 0.06), our results were better than previously reported comparison between these two techniques.[4] This indicates that a larger subset with longer follow up may be able to highlight the smaller the learning curve associated with RID technique. The RID technique relies entirely on the slider operation executed by the physician. Pulling the slider back increases the diameter of the device which causes enlargement of the cells, thus allowing better apposition of device with the vessel wall and enhancing stent–clot integration. This engages more clot fragments to prolapse into the device lumen.

Number of passes used

In the entire cohort, multiple passes for complete revascularization were needed in 17 cases. Two passes were used in 10 patients, three and four passes in 3 each and five passes in 1 patient. We experienced a good complete

Table 2. Rescue subgroup results (Tigertriever used as a rescue device for thrombectomy after failed first pass with other device, n = 5).

Mean age	63.4 (22.9)
Median age	62
Gender	3 M, 2F
Comorbidity	
DM	1
HTN	2
CAD	2
Hyperlipidemia	3
Location of occlusion	
MCA	4 (80%)
PCA	1 (20%)
Median ASPECT score	8
Mean ASPECT score	7.6
Mean NIHSS	14.6
Median NIHSS	13
IV rtPA before thrombectomy	1 (20%)
Device used for first pass	
Trevo	4 (80%)
Solitaire	1 (20%)
Median time from last well known to groin puncture (min)	171
Mean time from groin puncture to reperfusion (groin puncture to TICI 2b/3) (mins)	25
Completed revascularization	4 (80%)
Mean mRS at follow up	3.4
Median mRS at follow up	4
Mean follow-up duration (range = 1–90 days)	76.1
Median follow-up duration (days)	134.8
Good clinical outcome (mRS = 0–2) at follow up	4/5
Worsening neurological status	1 (20%)
No change in neurological status	2 (40%)
Improved neurological status	2 (40%)
Mortality at 1 month	0
symptomatic hemorrhagic transformation	1
Completed infarct	1
Asymptomatic hemorrhagic transformation	1

CAD: coronary artery disease; DM: diabetes; HTN: hypertension; MCA: middle cerebral artery; mRS: modified Rankin score; NIHSS: National Institute of Health Stroke Scale; PCA: posterior cerebral artery; rtPA: recombinant tissue plasminogen activator; TICI: thrombolysis in cerebral infarction.

revascularization (96.6%) rate at the end of all passes, with the remaining 3.3% (n = 1) attaining an mTICI 2a score at the end of procedure. Failure of FPE with Tigertriever was believed to occur because of summation of several factors. These include a firm atherosclerotic plaque which prevents complete deployment of Tigertriever within the location of occlusion.

Successful revascularization

Few prospective trials like TIGER have demonstrated efficacy of the Tigertriever.[11] This study compared data from 17 centers where Tigertriever was used, with previous prospective trials of Solitaire and Trevo devices. The primary efficacy endpoint of successful revascularization was achieved in 84.6% compared to 73.4% historical (p < 0.01).[10,11] Our study demonstrated equivalent outcomes (96.6%). After unsheathing, the device does not expand on its own. The physician can position the device correctly in relation to the clot allowing for accurate deployment and clot integration. The visibility of device enhances operator judgment of clot integration and retrieval (Figures 3 and 4).

In Figure 3, we highlight the angiographic visibility of the device and its effectiveness in the presence of native atherosclerotic disease. The operator is able to visualize the diameter of the expanded and collapsed stent retriever and based on experience and judgement, an early successful FPE may be achieved. The conformability of the device in a tortuous anatomy is highlighted in Figure 4, where an MCA occlusion is successfully relieved by the use of RID technique.

It has been noted that, in unsuccessful cases, the device tends to attain a bow-tie configuration where the central portion is collapsed while the proximal and distal ends are well integrated with the clot.[4] It has been hypothesized that the central portion of clot may have been firm and resistant to retrieval. A second pass with Trevo or Tiger 17 or aspiration catheter (Ace 68/ Red 68) proved successful in these cases.[4] The conventional thrombectomy devices were primarily designed for removing occlusive emboli. The presence of intracranial atherosclerotic disease (ICAD) may lead to partial recanalization. It is believed that stent conformability to the parent vessel may give Tigertriever an advantage over other devices in managing occlusions associated with ICAD. This effect is believed to mimic that of balloon angioplasty, where the narrowed vessel wall may be dilated in addition to capturing the clot.

Time to reperfusion

The groin puncture to reperfusion time observed in TIGER trial was 24 min.[11] The mean time to reperfusion was 19.9 min in our RID group and 25 min in ST group. Although not statistically significant a difference (p = 0.29), these results do represent improvement in revascularization times with refinement of technique. Whether these improved revascularization times amount to better survival rates in the long-term remains to be seen.

Clinical outcomes

We observed equivalent improvement in neurological status (mRS) in both subgroups (33–40%). Good clinical outcome was seen in 32.2% (n = 10) at mean follow up of 78.1 days, compared to 58% at 90 days in TIGER trial. Mean mRS in RID group was lower at follow up (2.6 vs 3.6 in ST group, p = 0.46). This could be attributed to various factors like nonrandomization of sample or variability of pre-operative mean NIHSS score (16 in RID vs 12.25 in ST group). As no statistical difference was observed between the two groups, we believe a larger and randomized sample, with longer duration of clinical follow up is necessary to conclusively demonstrate the clinical efficacy of each method.

Complications and safety outcomes

No intraprocedural or postprocedural complications were attributable to device use. The safety of Tigertriever has previously been established in various studies.[9,10] The combined primary safety endpoints of symptomatic intracranial hemorrhage (1.7%) and mortality in TIGER trial were 18.1%, compared to 20.4% historical rates.[10] The combined complication rate in our cohort was 9.6% (n = 3). While two patients succumbed despite successful revascularization, Spontaneous Intracranial hemorrhage (sICH) was observed in very few cases (n = 1). No correlation with device use could be drawn from our limited outcome. Presence of resistant clot may predispose to parent vessel/ perforator injury, due to traction caused by the partially expanded device while retrieval. Whether sICH occurred due to rapid revascularization, anticoagulation, traction to perforator vessels or superselective angiography, could not be conclusively verified.[12,13] The small number of complications like worsening neurological status and asymptomatic hemorrhagic transformation among the RID and ST groups were not attributable to device malfunction as postprocedural angiography did not demonstrate perforator or parent vessel injury. Historically, the device performed good in terms of safety in smaller vessels with median vessel diameter 1.6 mm.[10,14]

Emboli to new territory

No patient in our study developed new distal embolization. The rate of ENT was low (2.6%) in the TIGER trial as compared to previous studies (7.4%).[4] Some studies reported a lower usage of IV rtPA in candidates for MT, with a belief that IV thrombolysis can promote clot fragmentation.[14,15] Other plausible explanations may be the closed-ended design and the partial deflation during retrieval which enables en bloc removal of clot.

Tigertriever as a rescue device for failed first passes

This region of clinical practice has not been explored extensively by researchers. Although successful first passes and the impact of an FPE on clinical outcomes are being extensively studied, there are significant proportions of patients who experience a failed first pass and need a second device/ technique. This may be attributable to clot integrity and stiffness, tortuous parent vessel anatomy or experience of the neuro-interventionalist with a particular device/technique. There are no randomized studies elucidating the use of a specific device as a rescue technique.[16,17] In our small rescue thrombectomy subgroup, Tigertriever showed equivalent clinical outcome (40%). This effect has been documented in some retrospective studies.[13] This can be attributed to conformability of the device to the tortuous vessel wall and better clot–stent integration. This effect needs to be substantiated through larger randomized population-based studies.

Limitations

Our study has inherent limitations due to the retrospective nature. All outcomes were assessed by the treating physician and lack of core-lab adjudicated outcome assessment could contribute to a bias in the study design. The small number of patients in each group and limited duration of follow up are possible explanations for obtained statistical insignificance of our results. Some studies provide evidence that use of proximal balloon guide catheter for flow arrest improves recanalization rates.[18,19] We did not use any such technique in our patients. Unlike some previous trials, our data does not provide comparison of Tigertriever with other stent retreivers.[10] Since, our rescue thrombectomy subgroup had limited number of patients, drawing logistic regression for impact on clinical outcomes and comparison between RID and ST techniques for rescue thrombectomy was not feasible. We believe our study is a technical reprise of the benefits of a new stent retriever and we anticipate a larger sample size with longer duration of follow up in future. Although with the limited results, making a major recommendation may not be feasible at this stage, however our study demonstrates that there is potential in this new device which needs to be further explored by endovascular physicians worldwide.

Conclusion

The preliminary first-pass success rates of RID technique with Tigertriever compared to standard ST technique are encouraging. A larger sample size is needed to substantiate these results with clinical outcomes.

Declaration of conflicting interests

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

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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